



**Vol. II**  
**TRANSCRIPT OF RECORD**

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**Supreme Court of the United States**

**OCTOBER TERM, 1938**

**No. 441**

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**THE ELECTRIC STORAGE BATTERY CO.,  
PETITIONER,**

*vs.*

**GENZO SHIMADZU AND NORTHEASTERN ENGI-  
NEERING CORPORATION**

---

**ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT  
OF APPEALS FOR THE THIRD CIRCUIT**

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**PETITION FOR CERTIORARI FILED OCTOBER 27, 1938.**

**CERTIORARI GRANTED DECEMBER 5, 1938.**





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## AFTER RECESS.

GEORGE L. CLARK, recalled.

*Re-cross-examination (Continued).*

MR. MORRIS: Will you pass the witness that Exhibit 21?

By MR. MORRIS:

Q. I hand you, Dr. Clark, Plaintiffs' Exhibit number 21, which is this photostat of fourteen photograms. Will you tell me what number 9 is?

A. Number 9 is the finest fraction of finely divided number three Prest-O-Lite bag oxide.

Q. I wonder if you will repeat that, finer fraction of finely divided number three; number three is tetragonal PbO?

A. Pest-O-Lite bag oxide.

Q. Did Ferrari have any tetragonal PbO lines?

A. In his paper he—the table in his paper, he lists only metallic lead and lead suboxide.

Q. You don't know, then, whether Ferrari had found any tetragonal PbO in his lines, or not?

A. I haven't seen—of course, I haven't seen his films, and there is no statement in the paper to that effect except that the sample subsequently decomposed or changed.

Q. Then your answer to my question is that you don't know?

A. I don't know.

Q. All right.

THE COURT: I wonder if I could have the chart that was made from this with the colored lines. Have you got that available? There was one made, just a chart.

MR. WHITCOMB: We have it.

THE COURT: It was easier to follow. There it is, that is P-28, that is the one.

MR. MORRIS: Have you a copy of that for us? We have never gotten a copy of that.

THE COURT: It is only a working chart that was made from this.

MR. WHITCOMB: We will have them made.

THE WITNESS: That is the original.

By MR. MORRIS:

Q. So number 9 was the finely divided tetragonal  $PbO$ ?

A. No, that is the—that is the finest fraction from the finely divided Prest-O-Lite.

A. That is the finest fraction of finely divided Prest-O-Lite oxide?

A. Yes.

Q. What is the other?

A. Made by the Shimadzu process.

Q. All right, now, where are your working sheets for that number 9?

A. I don't know whether there are any.

Q. You never took any measurements of this newly-discovered or confirmed  $Pb_2O$ ?

A. Why, yes, the number 11, the finer fraction of finely divided number 7.

Q. Oh, that is 11?

A. I beg your pardon, number 10, finely divided fraction of number 6 is given in one of the exhibits presented this morning.

Q. Finely divided number 6, well, that is the same as Defendant's 2, isn't it? Isn't that the same as the one you handed me the other day when you were here?



A. Yes.

Q. So that you have your measurements for number 6, Exide oxide?

A. That is right.

Q. But I thought you told me the other day that the lines of number 6 and lines of 9, 10 and 11 do not correspond. Am I right?

A. Number 6 is the mixed oxide right from the mill.

Q. Yes.

A. And number 10 is the finest or the super-centrifuged, non-settling fraction from number 6.

Q. Yes.

A. And in this number 10 is concentrated in its finest fraction.

Q. Yes.

A. A spectrum which—another filtered spectrum was presented this morning of a film which, most of the lines of which correspond to the suboxide or a cuprite type of structure.

By THE COURT:

Q. Now, is that the blue on P-28, is that the blue?

A. That is right.

Q. That is marked  $Pb_2O$ ?

A. That is right.

Q. And that is the same as number 10 on your—

A. That is number 10.

Q. On Exhibit 21?

A. Yes.

THE COURT: All right.

By MR. MORRIS:

Q. So that what you did in 9, 10 and 11 was merely to take out what lines that appear in number 6?

A. The lines of lead and tetragonal  $PbO$ .



Q. So that there are no lines of lead and tetragonal  $\text{PbO}$  in 9, 10 and 11?

A. There may be a little in 9, but not in 10.

Q. Not in 10?

A. No.

Q. Any cubic  $\text{PbO}$  in 9, 10 or 11?

A. Cubic  $\text{PbO}$ ?

Q. Yes.

A. There is no cubic  $\text{PbO}$ .

Q. Oh, there is not?

A. No.

Q. You know that there is not any cubic  $\text{PbO}$ ?

A. There are two kinds of  $\text{PbO}$ , tetragonal and orthorhombic.

Q. We know that, but do you know that there is not any cubic  $\text{PbO}$ ?

A. Well, I never have seen any, or never have heard of any, or never found any record of any.

Q. Before Berzelius nobody ever heard of any  $\text{Pb}_2\text{O}$ , either, did they?

A. That is right.

Q. So are you saying that everything, like the Commissioner of Patents in 1849 said, close the Patent Office because everything that there is has been discovered, are you in that position with regard to chemistry—

A. Well, certainly not, as a science.

Q. —and crystallography?

A. Absolutely not.

Q. All right, so that we do know that there is no cubic form of  $\text{PbO}$ ?

A. At present, yes.

Q. But—

A. We don't know of any at present.

Q. Do you mean that there isn't any at present, or you don't happen to know of any at present?

A. I don't know of any cubic  $\text{PbO}$ , or know of any publication in which anyone has ever discussed any.

Q. What has publication got to do with the existence of cubic form of  $\text{PbO}$ ?

A. Well, I suppose that all of chemistry, the progress of chemistry necessarily depends upon the publication of experimental results.

Q. Surely, you didn't base your experimental results with regard to  $\text{Pb}_2\text{O}$ , say you found that because Ferrari found it?

A. No, sir.

Q. Certainly not. Then did you make no measurements of your lines on 9, 10 and 11?

A. I did.

Q. Where are they?

A. They are in the exhibit, whatever it is, this morning, from our research log.

Q. Well, which exhibit?

THE COURT: Pardon me, I wonder if you would just get me straight on this—

THE WITNESS: All right.

THE COURT: —by just putting the numbers on this thing that correspond with this. Now, that I am all right on, that is number 10.

THE WITNESS: That is right.

THE COURT: Now, what is this?

(The witness indicated the proper marking on the exhibit.)

By MR. MORRIS:

Q. So that the only measurements that you have for number 9, 10 or 11 are found in Defendant's Exhibit 2?

A. No, that is not the one, Judge Morris, I am sorry. It is the plaintiffs' exhibit presented this morning.

Q. Well, now, won't you pick it out—

A. Yes.

Q. —and give me the exhibit number? Perhaps it is 59, I think this is it, isn't it?

A. No, here it is.

Q. What is the number?

A. 53.

Q. 53?

A. Yes.

Q. So that 53 constitutes your measurements for what?

A. That constitutes the measurements specifically on 10. Of course, 9 and 11 were—had been compared directly with number 10 many times.

Q. Well, now, you have, of course, compared these, and there are many figures on them. Are there any lines on Plaintiffs' Exhibit 53 that are not found on Defendant's Exhibit 2?

A. Yes, surely.

THE COURT: I don't know, but I am mixed up in these exhibits. Which is 53 and which is 2?

MR. MORRIS: 2 corresponds to the 9, 10 or 11, whichever it is, that is the Exide one.

THE COURT: Yes.

MR. MORRIS: I don't know whether it is 9, 10 or 11.

MR. WHITCOMB: Do you want to use these that are marked? That will help you, these have got the exhibit numbers on them.

THE COURT: Exide oxide is 5 and 6, isn't it?

THE WITNESS: Exhibit number 2 corresponds to number 6, yes. That is the mixed, that is the mill oxide.

THE COURT: That is what I thought.

THE WITNESS: Unfractionated.

By MR. MORRIS:

Q. But 10 is a finely divided, 10 is a finer fraction of finely divided number 6, isn't it?

A. That is right, that is the final, non-settling, super-centrifuge fraction.

Q. Now, the material that you analyzed as Exhibit number 10 was all extracted from or obtained from the Exide oxide?

A. That is right.

Q. Material taken by Dr. Wilson—

A. That is right.

Q. —from defendant's plant?

A. That is right.

By THE COURT:

Q. And that was the stuff that was produced here—

A. This morning.

Q. —in the test tube this morning?

A. Yes.

By MR. MORRIS:

Q. Now, are there lines on 9, 10 or 11—let's stick to 10, that are not found in number 6, on Plaintiffs' Exhibit number 21?

A. Yes, there are.

Q. Why?

A. A few very faint lines which we have been unable to identify. Two of three of them appear to be sulphate, probably. In other words, in the mill oxide

there is—there is present some impurity, possibly by reaction with  $\text{SO}_3$  fumes, or something of that kind, in such small amounts that it does not appear in the original mixed substance, but appears only in this extreme fractionation.

THE COURT: Now, is there an extra copy of 21 that I could have? Dr. Wilson has mine. Has anybody got another one?

MR. MORRIS: I don't want mine.

THE COURT: All right, there is another one. Now, go ahead.

By MR. MORRIS:

Q. Are there any lines on 6 that do not appear on 10?

A. There are.

Q. Well, what are those lines?

A. Those are the lines which we have identified with metallic lead and with tetragonal  $\text{PbO}$ .

Q. All right, so—

By THE COURT:

Q. Those are the yellow and green lines?

A. Yes.

Q. On my chart.

A. Of course, it is perfectly true that two or three of the lines of  $\text{Pb}_2\text{O}$  fall very closely, in fact, practically coincide with the two or three of the lines of  $\text{PbO}$ , and, of course, that reservation must be made.

By MR. MORRIS:

Q. All right, what happened to the material of the product of your centrifuge, and how was it extracted, obtained from your centrifuge? I am speaking now

of the material which is number 10 on Plaintiffs' Exhibit 21.

A. As previously described, the material was suspended in—

Q. No, I want you to begin not with the original process, because that is in the record,—

A. Yes, all right.

Q. —but I want you to begin to take this material out of the machine after it has been subjected to the centrifugal force.

A. Then the low boiling oil in which the material is suspended is carefully evaporated at a low temperature, and the residue obtained, dried in vacuum, and, of course, preserved, stoppered up.

Q. What, stoppered up?

A. Stoppered up, yes.

Q. Stoppered up just like this here, Plaintiffs' Exhibit—

A. Well, originally it was, of course, sealed. That has been opened for X-ray and these chemical tests which I spoke of, so I brought it just as it was, one tube inside of the other.

Q. I thought you offered this this morning as Pb<sub>2</sub>O. Did you or didn't you?

A. Yes; I did.

Q. Is it?

A. Well, it is Pb<sub>2</sub>O with a small amount of impurity, yes.

Q. You kept that, it is now—

A. Well, it is fair to say that the sample has darkened since I have brought it from home, slightly darkened from what it originally was.

Q. Well,—

A. But I would be very glad to have, delighted to have your X-ray people make a pattern of that sample.

Q. You kept your sample prior to analysis as well protected from atmosphere as this one?

A. Yes, it was—

Q. Who was it requested that the sample taken by Dr. Wilson be forwarded to the respective parties or to you, particularly, with some sort of pentoxide?

A. I requested that.

Q. What was the purpose and object of that request?

A. It was simply to prevent any possible effect of moisture which might develop, keep the sample just as dry as possible.

Q. And there were tons of those samples, weren't there, that is, you could get a ton of that oxide from the E. S. B. Company, the defendant in this case, at any day you wanted, couldn't you?

A. Oh, I suppose you could.

MR. WHITCOMB: Oh, I don't know, we had plenty of trouble getting it.

By MR. MORRIS:

Q. Well, you got those samples,—

A. Those few test tubes.

Q. —anyhow, and they are all in evidence, your exhibits, or plaintiffs' exhibits, of a great many test tubes full?

A. That is right.

Q. But it was necessary to preserve that with something that would prevent air or at least the moisture of the air getting into it?

A. Yes.

Q. And this rare stuff that you have been the first one to isolate, and where you produced possibly—how much, a half gram?

A. That is just, of course, the amount that remains.



Q. Yes.

A. That is left. Of course, we have used some.

Q. But how much is there in there?

A. Oh, I suppose maybe half to three-quarters of a gram, or—

Q. You mean—

A. Half to three-quarters of a gram, maybe a gram.

Q. All right.

A. I haven't weighed it. That has been, this tube has been kept always in a vacuum dessicator over  $P_2O_5$  ever since it was formed.

Q. And the corks, these are the usual cork wood, aren't they?

A. Yes.

Q. Weren't they sufficient for excluding the moisture from the samples that were being forwarded to you?

A. Possibly would have been, yes, it just—that, was just a precaution.

Q. But it wasn't necessary to use any such precaution with regard to this newly discovered or isolated  $Pb_2O$ , was it?

A. It has been preserved with the utmost precaution until I brought it with me the day before yesterday.

Q. I see, but now, then, the precautions were relaxed?

A. Well, I don't—I don't think that it is—

Q. Is this the way you kept all the material—

THE COURT: Let him finish.

By THE COURT:

Q. You don't think that it is what?

A. I don't think it is—I think I would be perfectly willing to submit it as—although, as I say, it has darkened a little bit—as the product as originally formed.



By MR. MORRIS:

Q. Were or were you not being a little more exacting when you required our samples to be protected with pentoxide than you are with this sample, P 55, in the precautions which you have taken with regard to—

MR. MORRIS: Pass that to the Bench, please.

A. Well, as I say, this sample has been guarded with even greater precautions from the moment of its formation until I brought it with me.

Q. But when it got into Court it didn't need to be?

A. Well, that is—

Q. All right.

A. That is protected.

Q. That is cotton in the bottom of that test tube that I am just showing you, isn't it?

A. Yes, yes, just prevent it from bumping.

Q. I don't want to go into this at any length, you may go into it as much as you like, but I am only asking this question to pick up a thread which we will follow for a moment. You spoke of a new X-ray camera, can I call it that with propriety?

A. Yes.

Q. You compared that with, spoke of it as being a great advance over the old X-ray cameras, as I recall it?

A. Yes.

Q. If I recall aright you also spoke of its requiring, the old cameras, ninety-six hours, or something like that, and this one required one hour?

A. Yes.

Q. When did you get that, Dr. Clark?

A. These—you mean this new camera?

Q. Yes.

A. Well, that has been—we have had a gradual de-

velopment. Experimentally, that is, my students are continually working on better technique, making cameras themselves, and, as I said this morning, when we first began, about three or four years ago, getting into this lead problem, we had available only the General Electric equipment, molybdenum target. We utilized then the usual technique of sealing the material in a glass capillary and submitting it to the radiation. It took many hours to produce a pattern. It is no criticism of the apparatus, particularly, but we were able to then equip our laboratory with these very powerful copper target tubes. Of course, the previous cameras in the General Electric apparatus were no longer available, they couldn't be used for this purpose, and so we began the construction and design of the various types of cameras which you see on there.

The cylindrical camera was chosen because we could surround the circumference or put a film clear around the circumference, and we could evacuate the camera, or put drying agents or inert gas, whatever it may be, in it, and we could submit, therefore, the specimen to the radiation in the form—on wedge shaped holders, so that there would be no passing of a beam through glass or other types of containers, and all the films which have been submitted have been made on this type of camera.

Q. My question was when you got it.

A. When we got it?

Q. Yes.

A. Well, the first one we had in 1933, and, of course, we have had several, we have several of them now.

Q. And the time of exposure, that is an hour, isn't it?

A. That is an hour. There are a few exceptions.

Q. Plaintiffs' Exhibit 31 is a picture of that instrument, isn't it?

(Plaintiffs' Exhibit 31 was shown to the witness.)

A. Yes, that is right.

By MR. MORRIS:

Q. That is the outside, isn't it?

A. Yes.

Q. I refer you to Plaintiffs' Exhibit 60 for identification and ask you what that is.

(Plaintiff's Exhibit 60 was shown to the witness.)

By MR. MORRIS:

Q. And I read that, that that was exposed for three hours?

A. Yes.

Q. Am I right?

A. That is right.

Q. And what is it?

A. This is the aged Exide oxide which had been exposed to air. This one was taken with—for three hours because our tube had become quite—as it gets older, becomes weak, and with also the special purpose of bringing out by long exposure, if possible, weak lines which might be there.

Q. If Ferrari didn't have  $Pb_2O$ , did you?

A. I have a—I have, and I am firmly convinced, I have  $Pb_2O$ , especially from the fact that we have been able to concentrate this material with a cubic structure, a very logical cubic structure; by this fractionation method.

Q. If—

A. It is, I think, incidental that our results are independent results, entirely independent, may or may not have confirmed what he—what he had previously found.

Q. And in your results I remember you used the word "harmony", the other day. Your results are in perfect harmony with the results of Mr. Ferrari, aren't they?

A. They are in harmony in the sense that with both they found a face centered cubic structure. His value for the constant was 5.38; mine is 5.33, which is—

Q. Oh, you mean, you mean that Mr. Ferrari found the constant a sub zero to be 5.38 Angstrom units, and—

THE COURT: Somebody will have to explain this to me. I am sure of that, either now or later.

MR. MORRIS: I will get to the sub zero in just a moment.

By MR. MORRIS:

Q. —and that you found that the  $Pb_2O$  structure had shrunk down to 5.33 Angstrom units?

A. Well, I think that is—that is our constant value. I think that difference is without significance, it is simply the difference in technique.

Q. Technique?

A. Or accuracy of measurement.

Q. Well, I know, but you gave me a document here that is of the highest accuracy, didn't you, Dr. Clark?

A. Well, it is the highest accuracy from our date, yes.

Q. Well, but, you know, you puzzle me. Do the lines for the face centered cubic type of pattern for lead—do you get perhaps the same lines for lead that Ferrari did, the metal lead?

A. Yes, the check is very close.

Q. Now, as close as 5.38 to 5.33—

A. Yes.

Q. —Angstrom units?

A. Yes.

Q. And, Dr. Clark, any closer?

A. Yes, slightly closer, the reason being, of course, that we are dealing with this, in this suboxide, with broad lines, and, of course, in previous, in all the previous films with rather faint ones.

Q. Yes.

A. It is simply a matter of measurement, that is all it is.

Q. Well, that is all, that is all the X-ray test is, anyhow, isn't it, a matter of measurement?

A. Yes.

Q. All right.

A. Measurement to the best of one's ability.

Q. But with the 5.33 Angstrom unit a sub zero line, by making that fundamental change you are able to reproduce Ferrari, is that your thought?

A. Yes, yes, it is a euprite—

Q. How far would you have been at liberty to make a fundamental change and not reach Ferrari, to coincide with Ferrari?

A. Well, it amounts only to fractions, fractions of millimeters, as far as that is concerned. It would—I would put plus or minus upon my results, 5.33 plus or minus 04, probably.

Q. Well, you would have to get 05 to reach Ferrari, though, wouldn't you?

A. Yes, but we have no—I would want to see Ferrari's films before I would be able to see how accurate his were.

Q. You are able to explain in any film that you get, aren't you, each line that you get on that film?

A. Well, that is what we always try to do.

Q. All right.

A. But it isn't always possible.

Q. Will you explain this P-48, introduced this morning?

THE COURT: P-48?

MR. MORRIS: P-48, Pb at the top.

MR. WHITCOMB: Exhibit 48.

THE COURT: Yes, I will have it in a minute.

MR. MORRIS: P-48, of the plaintiffs. Angstrom units a sub zero, do you want that now?

THE COURT: Oh, no, I guess it would only make things worse.

MR. MORRIS: I think it will not, I think it will not, if your Honor please.

By MR. MORRIS:

Q. Will you tell me what the Angstrom unit is? If I understand it, I want a lesson at the same time, it is a unit of measurement of the X-ray, is it not, length measurement?

A. Wave length, yes.

Q. Wave length?

A. It is one-one hundredth thousandth of a centimeter; ten to the minus eighth power centimeters equals one Angstrom unit.

THE COURT: Well, all right, I understand what that is. I don't know what the a sub zero—

By MR. MORRIS:

Q. Now, can you tell me briefly what the a sub zero line is, in crystallography?

A. Could we have that picture of those lattice models?

THE COURT: Yes.

MR. MORRIS: Yes.

THE WITNESS: I think that would show.

By MR. WHITCOMB:

Q. Will you hold it so the Court can see it?

A. Yes. If we subdivide a crystal, that is, the result of X-ray analysis, subdivide it down just as far as we can get on the basis of this analysis we finally come to a little cell, the last thing, it is still a crystal, and that cell simply represents distribution of atoms or molecules in space, so the fundamental dimensions of that little unit cell, which, after all, is the measurement of distance between planes of atoms, is what we call the lattice constant, or a sub zero value.

By THE COURT:

Q. Does that cell repeat itself through all that?

A. Repeat—here is lead, right here (indicating).

Q. Yes.

A. In a big chunk of lead. There is another one here, here, here, all around, different directions (indicating).

Q. Yes.

A. Until you have the crystal you can see.

By MR. MORRIS:

Q. It is the fundamental measurement of crystallography?

A. Yes, that is right.

By THE COURT:

Q. What is the a sub zero part?

A. The a sub zero is the size, say particularly in a cubic crystal, is the size of that little unit cell.

By MR. MORRIS:

Q. Is the edge line, in other words, isn't it?

A. Yes, it distinguishes one substance from another, because it is a measurement of the distance between planes, or the architectural plan, whatever that may be.

By MR. WHITCOMB:

Q. Can you point it out on there to the Judge?

A: Yes, this one of lead here, you see, the a sub zero value for lead would be this string right along there (indicating).

THE COURT: I see.

By MR. MORRIS:

Q. That is 4.92?

A. 4.92.

Q. 4.92 Angstrom units?

THE COURT: That is all right, I believe I understand that.

By MR. MORRIS:

Q. And Ferrari found 5.38 for his so-called  $Pb_2O$ ?

A. Yes, I think, if I remember right, that is right.

By THE COURT:

Q. You found what?

A. 5.33 was the average of our results.

By MR. MORRIS:

Q. 5.33?

By THE COURT:

Q. He found 5 point what?

A. 38.

Q. Yes.



B. MR. MORRIS:

Q. Let's pass back now just for a moment to Plaintiffs' Exhibit 60, which is the film of aged Exide powder, gray oxide, which had been exposed to air. Am I right?

A. That is right.

Q. Will you point out there to us the  $Pb_2O$  lines, so-called, on that?

A. No  $Pb_2O$  lines there, that I can see.

Q. None on that? Why not?

A. Disappeared.

Q. You mean what disappeared?

A. That is the evidence, the evidence which we submitted before, in these "D" samples of five or six or seven per cent of lead suboxide, there are no lines in this pattern which correspond to that at all, all of which means that the  $Pb_2O$  initially present and on exposure to air on a watch glass, just simply standing out on a watch glass, completely disappears.

Q. Oh.

A. At least, goes below one-per cent or so.

Q. Now, if I understand you aright, the material of which you took the film represented by Plaintiffs' Exhibit 60 was exposed to the air at room temperature for some time?

A. Yes.

Q. For how long?

A. Well, that was, I think, just overnight, just in a watch glass, in a watch glass.

Q. Mr. Shimadzu says in his patent 150 that suboxide is almost but not quite as reactive as lead powder, his suboxide is almost but not quite as reactive as lead powder. I assume he means finely divided lead powder. Do you agree with Mr. Shimadzu on that?

A. The activity of the Shimadzu oxide taken out

of the mill is due very largely to the finely divided metallic lead.

Q. The activity or reactivity of lead powder, did you say, is due to the finely divided metallic lead?

A. Metallic lead.

Q. Of what lead powder?

A. Well, of any, any mixture where you have very, very finely divided metallic lead.

Q. Then you found  $Pb_2O$  is not as reactive as finely divided lead powder?

A. No, I don't believe it is, this fraction which we have out surprised us by being actually more stable than we thought it might be.

Q. Well, does that—

A. It can be maintained in vacuum, or it can be maintained in oxygen-free water, under oxygen-free water.

Q. Yes, but it was so unstable that it disappeared at room temperature overnight?

A. Yes.

Q. Have you figured out the number of hours that the lead dust is in the Hall mill in the Exide plant?

A. Well, I don't know, of course, I have no idea how long that is. The supposition is that the powder is removed fairly rapidly from the—

Q. Now, let me see if I understand what you mean by that, fairly rapidly, you mean perhaps what?

A. Well it is—it is conceivable, it seems to me, that while you can't measure any such thing as that, it is conceivable that some powder abraded off of the balls would be instantly removed from the mill, and, of course, collected. The suboxide, of course, can be protected for some period of time, especially, it might be surrounded by metallic lead, something of that kind.

Q. Well, now, the temperature has been shown at which the Hall mill operates as 340 to 345 Fahrenheit,

George L. Clark.

that is, with a thermometer in the position in which it has been shown that it is.

A. Yes.

Q. If suboxide vanishes and disappears overnight at room temperature do you think it is so stable that if it were in the Hardinge mill for a few hours or several hours at three hundred and forty or forty-five degrees Fahrenheit that it is not sufficiently reactive as to disappear?

A. Well, there is no question but what a large amount of lead suboxide must disappear in the Hall process. Of course, I must say this, that this sample is a year old, to begin with, and it was simply spread out on a glass very—in just almost a single grain layer.

By THE COURT:

Q. Which sample, please?

A. This sample we are speaking of, this film here.

MR. MORRIS: P-60.

THE COURT: All right.

THE WITNESS: Simply exposed in a very thin layer to moist air, and the pattern made on September 12th, or whenever it was.

By MR. MORRIS:

Q. Well, but we went into the question of how you kept your samples a while ago, didn't we, and we found until you brought them into court they were kept very carefully?

A. Yes, that is true, that is true. The Exide samples have been kept over  $P_2O_5$  all the time.

Q. So you would not have expected any change so long as it had been so carefully guarded as that?

A. No, not very much, at any rate.

Q. So you and I would agree, wouldn't we, that if

there had been any change in the chemical composition of the product which you left out overnight, that it occurred while it was so left out overnight?

A. Oh, substantially the largest amount, yes.

Q. Now, let's go inside of the Hardinge mill just for a moment, again. You attribute the fineness of the lead to the chemical reaction inside the mill, don't you?

A. I do.

Q. And that is due to the sliding off of one molecule of lead from the alleged  $Pb_2O$ , isn't it?

A. Yes, the dissociation of  $Pb_2O$ , which in its ultimate sense is an actual molecular process.

Q. Well, in my layman's, crude layman's way of looking at it, I happen to have two quarters and a nickel, they are combined to form a molecule, let's look at the quarters as Pb and the nickel as O. Now, if I take away one of those quarters, namely, one atom of lead, I have got  $PbO$ , haven't I?

A. That is right.

Q. Is that what you mean, does that illustrate the reaction?

A. That is all right.

Q. What becomes of the atom of lead?

A. That atom of lead may then undergo oxidation, or it may anneal itself, it may grow into crystalline lead.

Q. Do you think that in this mill as you have examined the process, there is any dearth of oxygen at any time?

A. There is a dearth of oxygen down in—in the inner surface of the balls.

Q. Is there in the Shimadzu process?

A. Under any oxidized outer layer which has not yet been removed there must be a deficiency.

Q. I am speaking of the atom of lead that has been split off from the two atoms and left  $PbO$  and a free

atom of lead, now, you mean that the only  $Pb_2O$  that you can contemplate or conceive of in the Hall process is shielded from the oxygen by an outer layer on the balls?

A. Not at all.  $Pb_2O$  has a temperature coefficient of dissociation which requires time.

Q.  $Pb_2O$  has what?

A. That is, it has a—it undergoes dissociation over a period of time. If more space—

Q. I thought it was rather fugitive.

A. Yes, it is rather fugitive, but even so there is a finite time for—

Q. Of how many hours?

A. Well, there is no way of knowing, that is all, all we can—

Q. You puzzle me, Dr. Clark, and I tell you where my trouble lies. A while ago I thought we understood each other very clearly, that finely divided metallic lead was very reactive, and, indeed, if I remember your testimony of some days ago it is pyrophoric to a high degree. Now, then, we have gotten down to atomic size of metallic powdered lead, and I am wondering when you reduced it to that size, and with a superabundance of oxygen, save as that lead, the oxygen cannot reach that atom of lead, when it is protected by the outside coating of the ball, I am wondering why that atom of lead, which is highly reactive at room temperature, is not equally highly reactive at a temperature of three hundred and forty or three hundred and forty-five degrees.

A. It is, there is no question about it.

Q. Well, then, would atomic lead be more reactive than a particle of lead a half a micron in diameter?

A. As a solid, why, it would, because its normal valences, of course, would not be satisfied.

Q. Are you indicating that lead is in a gaseous form or liquid form in the Hardinge mill?

A. No, I don't postulate that, it is simply there as a dissociated solid.

Q. Now, there are several other things I want to ask, but I am still puzzled, and I don't mind telling you so, as to the reaction you conceive of, which it seemed to me to reduce that free lead to atomic size, and it is highly pyrophoric, even when it is much larger than an atom, now, then, I cannot conceive of how those free atoms of Pb can get out of that temperature when they are in it for a long time, when that temperature is three hundred and forty to three hundred and forty-five. Will you try to make it clear to me, because I don't get it?

A. Yes, well, the thing as I picture it is this, the basis for the consideration, of course, is the presence in materials of this kind of exceedingly finely divided phases even of metallic lead, far beyond, so far as we know, the ability of any grinding process, nobody has, so far as I know, has ever succeeded in grinding metallic lead.

Q. Does the reaction have to be the  $Pb_2O$  reaction in order to account for its fineness?

A. It seems to me the perfectly logical thing, in the light of the eight reactions which I tried to outline the other day, that the first entrance of—we will postulate, first of all, before any abrasion can take place, before a product can be formed, some kind of oxidation must take place, we have an absorbed air film, oxygen; the next thing—which is governed by all of the physical laws of the environment—the next thing we can postulate is the oxygen entering, that is, the only way it can, is to enter in and combine with, in some way, the lead, and the process, as we have postulated it, is that metallic lead is able in the normal

state of affairs to take up into itself, into its lattice, a limited amount of oxygen, forming—still retaining a cubic type of structure.

Then, of course, as further oxygen is added, or as the—as the material remains a long time at high temperatures, or something of that kind, other oxygens may be added, and the whole structure rearrange itself, over a finite time interval, it may be very, very short, into a stable, more stable configuration of lead, one, oxygen, one, under other—remembering that all these eight things are going on at one time, that such a latticework, in case it may be in a position for the moment with a deficiency of oxygen, relatively speaking, may prefer from the standpoint of its free energy, or something of that kind, to separate itself into lead and  $PbO$ , thus forming, as we know, in a large crystal, which would disintegrate, which would have to go through a type of molecular process, into lead and  $PbO$ . Then, as I say, this metallic lead, formed by the dissociation, as I say, of lead suboxide, can either go right on up in the oxidation process, in which there must be this lattice rearrangement, or lead suboxide formed as the first stage in which oxygen is first taken on, may break itself up into a more stable lead lattice and a more stable  $PbO$  lattice.

This lead then being regenerated, for the purposes of—which may then oxidize, or, under certain conditions that we know, well known in the field of metallurgy, lead atoms may actually be enough of them to get together to form a crystal of lead, and that that crystal may actually grow into a little pellet, a little bill, thereby becoming inactive and no longer entering into the equilibrium at all. If we could keep metallic, atomic metallic lead and molecular  $PbO$  there, then the possibility would be to make them combine and recombine to form  $PbO$ , if we had the proper energy



conditions, or we might reach equilibrium where there would be a much higher proportion of  $Pb_2O$  than there is in the product, but the equilibrium, if such equilibrium does exist, is being—a tendency all the time is for the dissociation of  $Pb_2O$  into lead and  $PbO$ , because the lead, that finely divided lead can oxidize and be removed from the equilibrium, or it can crystallize and grow, being no longer active enough to enter into this equilibrium.

By THE COURT:

Q. Would you mind defining equilibrium as you are—

A. Well, it is this equation with two arrows,  $Pb_2O$ , arrows,  $Pb$ , plus  $PbO$ .

Q. What does that mean?

A. If we could keep all those three solids, right there, without change, then at a given temperature, as we know in chemistry, for all reactions and dissociations, there would be a place where certainly the rate of dissociation of lead suboxide into lead plus  $PbO$  would exactly equal the rate of combination of lead and  $PbO$  to form  $Pb_2O$ . That is what we call a condition of equilibrium.

By MR. MORRIS:

Q. That could occur in solid phase?

A. If those materials were kept in essentially molecular dimensions, only.

Q. Then, in short, if I understand you, your conclusion is this, that a material that had survived as  $Pb_2O$  in the Hardinge mill, possibly for many hours, at a temperature of three hundred and forty to three hundred and forty-five degrees centigrade, would disappear at room temperature if exposed to the air overnight?



THE COURT: Pardon me, you said centigrade; do you mean Fahrenheit?

MR. MORRIS: Fahrenheit, yes, sir, that is three hundred and forty to three hundred and forty-five Fahrenheit, thank you.

A. Only provided that the powder were in a very thin layer, and in moist air. We know, of course, we have done experiments in a vacuum desiccator, and things of that kind, in which we find it very stable.  $Pb_2O$ , and also metallic lead, it must be said, is most sensitive to oxidation when in the presence of moisture, although the oxygen and the moist surface must come in contact.

Q. All right, let's pass that.

A. All right.

Q. Could you give me a theory equally as sound for the fineness of the lead if you assume no  $Pb_2O$  reaction in the Harding mill, and assume only a  $PbO$  reaction?

A. Well, of course, you have no—

Q. I am asking you as a scientist, now.

A. Yes, I know, I am trying to answer the best I can, I am more or less thinking aloud. We have no reducing atmosphere, of course. We know that we can produce exceedingly finely divided lead by reducing an oxide with hydrogen, or under suitable method, but no such condition here applies. We might think of the reduction of  $PbO$  by metallic lead—

Q. Now, let's have no  $Pb_2O$  reaction in that mill, now, let's get it out and not have it, and I think my question was whether you could think of any hypothesis upon which you could account for the existence of lead in as finely divided form if a chemical reaction within the mill is assumed to be  $PbO$  instead of  $Pb_2O$ .

MR. WHITCOMB: I think he ought to go ahead with his answer, your Honor.

THE COURT: Well, he is going to be allowed to.

MR. WHITCOMB: He was interrupted:

THE COURT: No, he wasn't interrupted, he finished his answer and then Judge Morris repeated his question.

MR. WHITCOMB: Would you mind repeating—

THE COURT: He wasn't satisfied with his answer.

MR. WHITCOMB: Would you mind asking the witness if he was through?

BY THE COURT:

Q. Were you through?

A. Well, I was just—it is perfectly all right, I just wanted to get clear what Judge Morris—

THE COURT: Read that last question of Judge Morris's again, Mr. Rodebaugh. You can start all over again, if you want to.

MR. MORRIS: Yes.

BY MR. MORRIS:

Q. My question presupposes the non-existence of the  $Pb_2O$  or any molecule of it in the Hardinge mill at any moment, and I am presupposing that the chemical reaction that takes place in the Hardinge mill is  $PbO$  reaction, and I am asking you as a scientist whether on that assumption and hypothesis you can account for the presence of lead, the product as finely divided as the product that you have in your samples from the Hardinge mill.

A. Under such a hypothesis I think it is entirely conceivable that when a lead oxide is abraded off it

might tear bits of lead, which is, of course, the lead is undoubtedly dendritic, and may be brittle—not brittle, no, but perhaps crystalline, in the sense that it might—might break off pieces of lead from the underlying ball, and even under my hypothesis or my theory I also—I also would include that distinctly as a possible formation of some lead.

By THE COURT:

Q. Well, now, let's see, does that answer the question "yes", then?

A. No, I haven't finished—

Q. All right.

A. —yet. I don't believe, now, this is as far as I can go, because I don't suppose anyone can know, I don't believe from my own experiments that it is possible to tear off metallic lead or to grind it off and get it as fine as can be actually produced or as is actually present in many of these products.

By MR. MORRIS:

Q. Products of the Hardinge mill, now, I am not speaking about the Shimadzu products now, I am talking about the product of the Hardinge mill, the gray oxide.

THE COURT: That is the Exide oxide.

THE WITNESS: Yes.

THE COURT: The Exide oxide.

MR. MORRIS: Yes, sir.

THE COURT: What we have called—

MR. MORRIS: The product of the Hardinge mill, the gray oxide, the Exide product.

THE COURT: Yes.

MR. MORRIS: The Electric Storage Battery Product.

THE COURT: What was that question?

THE WITNESS: Well, it is perfectly—I am very frank to say this, that there is a fairly good particle size of lead in the Exide sample, that is, the lead lines are dotted, as the X-ray patterns may show. Now—

By MR. MORRIS:

Q. Well, now, just pardon me for a moment, because I think Judge Kirkpatrick might like to see that. No, I am wrong, I thought for a moment that my recollection was that the dots on 10 and 11 were such dots, but I am wrong about that, and I find one of those illustrations here. Will you proceed?

A. Let's see;—

Q. In 10 and 11 dots were intended to mark your so-called  $Pb_2O$  lines.

A. —in number 5, Judge Morris, you will see what I mean by dotted lines.

Q. I know.

A. They are the second and third—

Q. I know what you mean, but just for the moment I got confused in my mind.

A. Now, there is no way of knowing whether that lead has grown by an annealing process or whether it has been torn off in that size.

Q. Well, I wonder if you could give me an answer "yes" or "no" to my question with respect to the Exide product, the gray oxide.

A. I am afraid I don't know.

Q. You don't know whether the product of that fineness could be accounted for on the assumption that the only chemical reaction in the mill is the  $PbO$  reaction, or not?

A. The only data, of course, which I have are the X-ray patterns, and upon the basis of that I couldn't say.

Q. On which—

A. I couldn't say—

Q. I see.

A. —as to the lead particle size.

Q. I see.

MR. MORRIS: Will your Honor be good enough to turn to Plaintiffs' Exhibit 48, which we started in some time ago, but haven't gotten to it?

By MR. MORRIS:

Q. You have, too, haven't you, P-48? Where did you get your Pb that is used in that exhibit, please, Dr. Clark?

A. This was a—this particular sample of metallic lead was obtained from our chemical storeroom.

Q. Do you know anything about its purity?

A. This, if I remember rightly, was—

Q. Will you suspend just a moment?

A. I beg your pardon.

(Interruption.)

By MR. MORRIS:

Q. Now, you got your lead from the storeroom or whatever you call it in the University of Illinois?

A. Yes.

Q. Do you know anything about its purity?

A. Well, if I remember right it was the Eimer and Amend's, spectroscopically pure lead.

Q. You used your usual care and skill and precaution in getting that lead in its pure form into the camera?

A. Yes, it was—it was very hard to handle, got to be handled—

Q. Yes, but you did?

A. Yes.

Q. You handled it?

A. Exactly.

Q. All right, so that when you got it in that capillary tube in the camera it was still pure Pb, wasn't it?

A. As far as I know.

MR. MORRIS: Now, I wonder if you will be good enough to let us have that easel with the paper on it, please?

By MR. MORRIS:

Q. Will you tell me what those lines are that are not checked on this?

A. Some of those are beta lines, very probably, and there may be three or four lines there due to very slight amount of impurity.

Q. But, frankly, my trouble is this, Dr. Clark, the lead lines are checked, aren't they?

A. Yes.

Q. And all the lead lines are checked?

By THE COURT:

Q. Well, would you mind telling me the mechanics of this thing? What is it? What do these columns of figures mean?

A. That is simply a numerical measurement on a film.

Q. You start here where it says "line"?

A. Line.

Q. Those are the different lines?

A. Yes.

Q. That is the first line you made, from the left, is that right?

A. That is right, from the left.

Q. And you found it was 3.5 millimeters from where?

A. From the so-called zero position.

Q. All right.

A. On the film.

Q. Zero position. Then there is a theta here. What does that mean, that column?

A. That is the angle, the angle of that line, that is the measure; here is the main beam of X-ray that goes right on through, and here is the diffracted beam, and that is the angle between.

Q. Well, it has something to do with the curve of the line? Or has it?

A. Well, it is the angular distribution of the line. We have a linear measurement, which is in column two, and in column three we refer it back, you see, to this angle between the diffracted beam, that is, the beam that is bent, and the beam that passes right straight on through.

Q. And then the next thing?

A. Then we have the sin of half of that angle.

Q. That is another check on the angle?

A. Well, we divide the angle by two and take the sin of that.

Then the "d", the value of "d" is calculated from the familiar equation,  $n$  times lambda equals  $2d$  times sin of theta. "d" is the distance, and lambda is the wave length of the X-ray beam.

Q. All right, "indices"?

A. Indices are the particular kinds of planes, the planes to which the given set of spacing belongs.

Q. That is a conclusion, that last, the last column is a conclusion?

A. Yes.

Q. From the other data?

A. That is the direction. You see, as you look at

this lattice here in various directions, like this (indicating), you have all sorts of parallel planes through it.

Q. Yes, but those indices, you don't measure that—

A. No.

Q. —from anything on the picture?

A. No, that is a calculation.

Q. That is arrived at by calculation?

A. Yes.

THE COURT: All right, well, I have an idea about it.

By MR. MORRIS:

Q. If you could get this many additional lines that you cannot account for when you are using, taking the X-ray diffraction pattern for pure lead—question withdrawn—maybe you can find for me some cuprite structures in those additional lines there. Can you?

A. No, I don't think so. Most of these lines, of course, can be—if not all, I don't just remember, but I think most of them, if not every single one, can be accounted for as beta lines, but not a filtered beam, on those big charts which you have, this same type of analysis, that is, those large mathematical charts, same type of analysis is made, in which the—no, these charts, like these (indicating).

By MR. WHITCOMB:

Q. What exhibit is that?

A. 59.

Q. 59?

A. D-2 will show that better, I think.

By MR. MORRIS:

Q. So it is unnecessary to assume the presence of any  $\text{Pb}_2\text{O}$  to account for any of those lines; is it?



A. You mean in this spectrum?

Q. That is right.

A. The most important lines are—

Q. Lead lines—

A. —completely missing.

Q. Lead lines, lead lines, aren't they?

A.  $Pb_2O$ , yes.

Q. No, I am afraid we are talking at cross purposes, Dr. Clark. The most important lines in that are the Pb lines, or the  $Pb_2O$  lines, or—

A. Pb lines, but I say missing completely from this table are the important  $Pb_2O$  lines.

Q. I see. Dr. Clark, you have given in your work sheets or in your log, and you haven't given any other place any tested explanation for those lines other than lead lines, which you found in your diffraction pattern for lead, have you? I mean, the only explanation you have given for those lines to me at all is what you have given orally just now, no explanation appears in any of these sheets, work sheets, that you have given to me?

A. Well, I am not sure I know just what you mean, except in—

Q. Now, let me see if I cannot make it clear.,

A. Yes.

Q. You gave me the work sheets which have been introduced in evidence.

A. Yes.

Q. Those are all you gave me. Then I would be unable to find anywhere in there any explanation or experimental demonstration of what those lines other than the lead lines are on Plaintiffs' Exhibit 48, for lead, pure lead.

BY THE COURT:

Q. Well, now, are there any lines on 48 which are not lead lines?

A. Those, the ones that are checked, of course, are calculated, they are all calculated with a single wave length, and the ones that are checked are the known indices, the known planes, known values.

Q. Oh.

A. For metallic lead, but this beam, as I say, contained another component, which would give another faint line.

Q. Well, now, look at this chart, which is really simply a simplification of one of the photographs.

A. That is right.

Q. I looked at the lead strip. There are, as I figure it out, about twenty-three lines there?

A. That is right.

Q. There are twenty-three lines here in your Exhibit 48?

A. Well,—

Q. Now, does that mean that this yellow chart, which is also number 2 on Exhibit 21, that that is what your supposedly pure lead gave you, of which only eleven lines have been identified as lead lines?

A. Those are the first eleven lines, on this—of course, this pattern was only taken to about .8 Angstrom units. The first—yes, first eleven lines on that pattern are these which have been indexed on the side.

Q. Have they been checked, you mean?

A. Yes.

Q. Yes, so, a lot of these yellow lines that you marked yellow on this chart are not lead lines, as far as is known?

A. Yes, those are lead lines consistent with, let us say, P-56, Plaintiffs' Exhibit number 56, where lead was used to calibrate the camera.

By MR. MORRIS:

Q. Well, if these are beta lines instead of alpha lines for—withdrawn.

If the lines on Plaintiffs' Exhibit 48 unchecked are the beta lines for lead instead of alpha lines for lead that could be quickly ascertained—

A. Yes.

Q. —and determined, couldn't it?

A. Exactly.

Q. You weren't using any screen, then, in this instrument?

A. That is right.

Q. It was the cylindrical form of chamber?

A. Yes.

Q. With a single aperture?

A. Yes.

Q. Circular in dimension, round?

A. Yes.

Q. Of what, forty millimeters?

A. You mean the pinhole size?

Q. Yes.

A. About forty thousandths of an inch.

Q. Is that forty millimeters, or not?

A. No, forty millimeters would be four centimeters.

Q. No.

A. This is very, very tiny—

Q. All right.

A. —size.

Q. Dr. Clark, in Plaintiffs' Exhibit 59, which has all these figures, and begins "Complete Tabulations for C83 Film." Camera constant 1° gives 1.215 mm.,"—what, I can't read the next, what is it?

A. Colog.

Q. Oh, yes, colog. equals 1.91542. What did you use for that experiment?

A. That was a sample prepared from lead oxalate.

Q. I think you told me that in your lead oxalate

you used—tests—you used a three hundred and ten degree constant temperature. Was this one made that way?

A. I could tell you exactly—C83 was lead oxalate, was a sample of lead oxalate prepared at 330 degrees in vacuum, heating for two hours.

Q. 330 degrees in a vacuum, heating for two hours?

A. Yes.

Q. Well, now, what does this exhibit purport to shew, Dr. Clark?

A. This is a complete analysis of all the lines which appeared on that film, and with the distribution of lines or the identification of lines definitely between lead, red  $PbO$ , and at least five lines which stand out by themselves for  $Pb_2O$ . The purpose of this—

Q. Can you give me those five lines?

A. I beg your pardon?

Q. Those five lines are what number?

A. The ones designated out there on the very edge by X's.

Q. You mean under "Pb": the column after "d"—oh, no, no, the last column?

A. Yes, that is right.

Q. I am sorry, Doctor. Will you proceed, please, can you give me the numbers of those? Are they 4, 23 and 24?

A. Yes.

Q. Yes.

A. The strong line of  $Pb_2O$ , which is very characteristic of it, is the one, the 2.609 standing out.

Q. Is the one what, please, Dr. Clark?

A. With the "d" value of 2.609. These are simply all—as you can see, every single line is there, under the two columns, log. sin of theta.

Q. Yes.

A. And log, sin of theta, plus a constant.

Q. Yes.

A. Is the provision made for identifying any line which might be the beta line, the one beta line of the other.

Q. Dr. Clark, will you tell me why you used 330 degrees in a vacuum?

A. This just happened to be one of the whole series of experiments in which the temperature was varied, the time, and various conditions.

Q. Well; I see. Would you have any different results had you used a temperature of 310?

A. At 310, which is the sample C119, for which we have microphotometer curves, we obtained stronger, that is, more intense  $Pb_2O$  lines than we did at 330, or at any other temperature, but there was some there even at this temperature.

Q. Well, now, when you tell me that you operated that other sample at 310 degrees, you mean within variations to what extent?

A. Well, the decomposition of lead oxalate, that is, at least, in so far as its reproducibility of the product is concerned, is exceedingly sensitive, and certainly the temperature in order to reproduce a sample made, let us say, at 310 degrees, in which we have a thermometer, good thermometer present in the tube, must be within at least one degree of 310, to reproduce a product with the same distribution in it.

Q. Well, now, have you your thermometer sheet? I suppose you use a recording thermometer when you are making a test that is so exacting as that one, don't you?

A. No, just a regular, just a—

Q. You don't?

A. —ordinary thermometer.

Q. Human reading, and not mechanical recording?

A. Yes.

Q. Well, then, of course, where it is so exact, I assume that you make a memorandum each minute, or each minute and a half of the temperature readings, don't you?

A. They are—the temperature is kept, I mean, the temperature is watched very carefully.

Q. Well, now, which do you mean, watched, or kept, Dr. Clark?

A. Well, I mean it is simply watched and the temperature kept right at the—by varying the current, say, through the electric furnace.

Q. That is, if the temperature tends to run up you would reduce the current?

A. Yes.

Q. And if it tends to run down you would increase the current?

A. Yes.

Q. And thereby you can hold the temperature at the 310 degree temperature within a variation of one degree?

A. It can be done, yes.

Q. No, but was it done?

A. It was, yes.

Q. Now, what kind of heat did you have, a power line?

A. Yes, yes, power.

Q. A. C., or D. C.

A. A. C.

Q. Do you know the normal voltage?

A. One hundred—averaged about—it is ordinarily about one hundred and fifteen volts, I think.

Q. Well, of course, you were running a scientific laboratory there, you know the voltage that you used, didn't you, and you know now the voltage that you did use, don't you?

A. Well, I wouldn't say that I knew it exactly, no.

Q. Well, are there ever any voltage variations on that line?

A. The voltage was not—the constancy was the temperature—

Q. It is not constant?

A. Temperature was maintained.

Q. But what I am trying to get at is as to whether the voltage is constant, and no variations.

A. It is very constant, yes, I mean—

Q. It is?

A. —under normal conditions.

Q. Well, now, isn't it necessary for you to know the voltage variations in order to aid you in holding your temperature constant?

A. Well, there was no—no purpose in doing that so long as the thermometer was right there in full sight, which could be—and the temperature kept as nearly as possible at 310 degrees.

Q. You mean the human control over temperature on a line having voltage variations is so exact that you may maintain a temperature of 310 degrees within one degree? That is 310 centigrade or Fahrenheit?

A. That is centigrade.

Q. Yes.

A. Well, I would say that, to be perfectly sure, that, at least, it was within certainly two degrees in this experiment.

Q. Well, now, Doctor,—

A. As a maximum.

Q. Now, Doctor, please, won't you have my question read to you?

MR. MORRIS: Will you read it, Mr. Rodebaugh?

(The question was repeated by the Reporter, as follows: .



"Q. You mean the human control over temperature on a line having voltage variations is so exact that you may maintain a temperature of 310 degrees within one degree? That is 310 centigrade or Fahrenheit?")

MR. MORRIS: I think it is my mistake, I am sorry.

By MR. MORRIS:

Q. Well, did you or didn't you have any device in your line to insure constancy of current?

A. There was not.

Q. You had no record of your experiment, you have no record of the temperature of your experiment, have you? I am not speaking of memory, I am speaking of written documents.

A. Well, I have, I have a—yes, I have a memorandum of the actual—

Q. May I have it? I thought I had all that you had, Dr. Clark.

A. No, I didn't know that you would want that.

Q. Oh, yes, I do. Now, the 310 degree sample was what number?

(The witness indicated the experiment.)

By MR. MORRIS:

Q. All that memorandum says of temperature is 310. It covered a time of how much? How much time did the experiment require?

A. That was two hours, too, I think.

Q. Did you do that personally?

A. This was done by Mr. Wood.

Q. Well, would you just assume, Dr. Clark, in a question of this magnitude, involving the discovery in 1935 of a new compound somebody else would make an experiment which required an exact temperature



within one degree where they kept no detailed record of the temperature?

A. We were interested in these experiments from a purely experimental point of view, to get an idea of the approximate temperature or the approximate conditions in which a sample could be prepared with lead suboxide present, or with a maximum amount of lead suboxide. There was no intention at any time of going to such extremes in the way of experiment or anything of that sort, it was just a preparation of samples, that is all.

Q. Now, did you use the phrase "approximate temperature" in this last answer? I thought you did.

MR. WHITCOMB: Read the answer.

MR. MORRIS: Will you read the answer?

(The testimony was repeated by the Reporter, as follows:

"A. We were interested in these experiments from a purely experimental point of view, to get an idea of the approximate temperature or the approximate conditions—")

By MR. MORRIS:

Q. Approximate, all right. Then you don't know as a fact that that temperature did not vary two, three, four, five degrees, do you?

A. Well, I know that—I know that Mr. Wood did maintain the temperature, the operator was continuously present during the experiment and operated and watched the temperature continuously with great care.

Q. Well, if the departure from 310 had been even as high as three degrees it would not have made any particular difference in this experiment, or not?

A. Not, no, it would not.

Q. All right. Now, what kind of a thermometer did you use to measure your temperature?

A. It was a mercury, mercury thermometer.

Q. Well, do you know what your technique was for finding out when to adjust the voltage control on your furnace, or Dr. Wood's technique?

A. He had, of course, he had a resistance in series, and by watching temperature, simply, simply—

Q. All right.

A. —kept the temperature as constant as possible.

Q. Do you know whether there would be any drift in the temperature after changing the controls?

A. I don't know as to that, I didn't see that.

Q. So the only entry we have with respect to temperature is 310?

A. That is right.

Q. Now, there is another phase that I want to take up now, if you don't mind.

MR. WHITCOMB: How about a recess?

THE COURT: What did you say?

MR. WHITCOMB: Could we have a little recess?

THE COURT: Surely, all right; ten minutes.

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(Recess at 3.15 o'clock P. M.)

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#### AFTER RECESS.

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*Re-cross-examination* (Continued).

By MR. MORRIS:

Q. If my information is correct, the books in the English language that give substantially accurate

statements as to proper techniques to be used in taking and interpreting X-ray "powder-method" diffraction patterns are, "The Crystalline State" by W. H. and W. L. Bragg—

By THE COURT:

Q. Before you leave this matter, we were talking about such a control of temperature and voltage and that sort of thing, that has to do solely with the experiments on the oxalate?

A. Yes.

Q. The experiments you made on the product of the plant do not require any furnace or any heating?

A. Nothing whatever.

Q. Or any control or anything?

A. That simply—

Q. I was going to ask the question why did you make oxalate experiments at all?

A. The purpose of the oxalate experiments running parallel with this was simply to test the information in the literature, of course, to run as nearly parallel with Ferrari and Le Blanc and Darbier, and these other people who had used it before.

Q. That is to parallel other experiments that had been made?

A. Yes.

Q. And had to do solely with the existence of the substance, and nothing to do with its existence in the product of any mill?

A. That's right. It was an independent and entirely separate experiment, just to see if lead suboxide was formed, or what was formed by this compound lead oxalate, which is not a commercial process in any sense of the word.

Q. Don't you think that would tell us—if it confirms it, your hypothesis would be that such a chemical substance did exist—

A. Yes.

Q. —and could be identified?

A. Yes.

THE COURT: All right. I just wanted to get a setting of this. Now, you may go on.

MR. MORRIS: Will you read as far as I got with my question?

(The question was repeated by the reporter as follows:

“Q. If my information is correct, the books in the English language that give substantially accurate statements as to proper techniques to be used in taking and interpreting X-ray ‘powder-method’ diffraction patterns are, ‘The Crystalline State’ by W. H. and W. L. Bragg—”

By MR. MORRIS:

Q. To which I will add the following, “The Crystalline State” by W. H. and W. L. Bragg, “A Study of Crystal Structure and Its Applications” by W. P. Davey, and “The Structure of Crystals”, by R. W. G. Wyckoff, and “Applied X-rays” by G. L. Clark. Am I right?

A. Right.

Q. No substantial disagreement on this topic among those scientists or authors, is there? They are in substantial accord on the subject?

A. I think so. Of course, I might simply say that my order book is not so exhaustive in any sense in presentation of details.

By THE COURT:

Q. May I inquire which of those books is the most elementary?

A. Well, that is rather hard to say. The Bragg book goes back to 1916, I guess, and it is very easy to read. It is not so exhaustive, possibly, in its details. While I don't want to speak unnecessarily about my own, my own book is meant simply as a broad question of the whole field of X-rays and does not specialize at all in the details of crystal analysis.

Q. If I should ever get to the point that I should want to consult a book, which one will you recommend?

MR. MORRIS: Don't be modest.

By THE COURT:

Q. Don't be modest. I mean, would your book be a good one to read, for me, which is adaptable for some such purpose as this?

A. Well, the original intention of it was for a reader not professionally familiar with the subject.

THE COURT: Well, I guess that is a good answer. I think I would qualify.

By MR. MORRIS:

Q. I thought yours was about as easy to read as any of them?

A. I think—

Q. These authors are in substantial accord, I think, you told me?

A. Yes.

Q. My understanding is that your work in connection with this litigation has been done exclusively by the powder method, has it?

A. Yes.

Q. Was your technique in taking and interpreting your powder-method diffraction pattern in connection with this litigation substantially in agreement with

that described in the books that we have just enumerated?

A. Why, insofar as we could, yes.

Q. Is the powder-method diffraction pattern of a given substance one of the characteristic properties of a substance by which it may be identified when the proper precautions are taken?

A. Yes.

Q. What are the precautions in the case of "powder-method" diffraction pattern of an unknown substance?

A. Well, of course, there are—I don't know whether you just refer to experimental, but the sample must be put in proper condition, if it is not already so, so that those smooth powder lines are obtained, so that a good pattern is obtained, and, of course, those lines must be measured with as much accuracy as possible, taking into consideration the width of the lines and so on. And, the attempt made to—if the substance is supposed to be a single powder substance, to make the interpretation, to make the pattern fall together so that all the lines will agree with the single powder substance in the configuration.

If the sample is a mixture, of course, then the attempt must be made to put together those lines, so as they correspond, especially if there is any question as to the—what one of the other constituents might be. It is not easy with the mixture, it is a difficult matter. I don't know whether that answers everything or not.

Q. Would it be helpful, Dr. Clark, if the diffraction pattern of the unknown substance were taken on the same photographic film with the diffraction pattern of a known substance, in such a way that the two patterns are side by side, for example?

A. That is very frequently done.

Q. Is it helpful?

A. It is helpful in calibrating, and in locating in the calibrating any inaccuracy of the camera, because the known substance will, incidentally, give that, and it will give you an approximate idea of the spacings and so forth of the new unknown pattern.

Q. My associate Dr. Davey wants to know whether that known substance that would be used in such a case would not be better, almost indispensable that, that known substance be of complete purity, I assume chemically known sample?

A. Yes.

Q. Or the same thing you are searching for?

A. There are standard materials that are often used by X-ray people.

MR. MORRIS: What was that answer, please?

(The answer was repeated by the reporter as follows:

"A. There are standard materials that are often used by X-ray people.")

By MR. MORRIS:

Q. You are speaking of chemically pure substances, one that is chemically known and a chemical standard?

A. Sodium chloride, very pure metallic copper—

Q. I am wondering, if you are doing with diffraction patterns, or something that is interpreted in the light of diffraction patterns, I am assuming the presence of an unknown substance,  $Pb_2O$ , for instance, and I am wondering whether you would not need to employ on the same film with this diffraction pattern, the pattern of a known substance, that is a chemically known substance?

THE COURT: If Dr. Davey wants to ask a

question, it is all right, as far as I am concerned, if we can save time by it.

DR. DAVEY: The intent of the question is not to refer to any calibrating substance, or inaccuracy of film, but in terms of identification of unknown substances. Take, if you want to identify a sample whose chemical composition you don't know at the moment, you can identify it. This is the question, can you identify it, if you take the same films alongside of a diffraction pattern of a substance which you know, and show that the two patterns are identical? For instance, if you wanted to identify an unknown metal, and you would try by the diffraction pattern of that unknown metal, again, for convenience, and compare it with the diffraction pattern of a known metal—

THE COURT: If you compared it with the diffraction pattern of a known substance, and it turned out that the two were identical, and you wanted to know what the unknown substance was, I could pretty nearly answer that myself, the answer is yes.

THE WITNESS: Yes.

By DR. DAVEY:

Q. If you do that too, don't you need to calibrate your film and still compare your readings line by line with the known readings of a chemically known standard material, in other words, to still shown a coincidence? I am speaking in general terms now, not with the identification of material by X-ray diffraction methods, or methods of viewing coincidences of lines between the unknown specimen and the mechanically known material?



A. You mean to exclude all calculations or any thing of that sort? You mean just simply a straight identification if you had a face centered pattern, that that was therefore the unknown, the face centered pattern?

Q. What I am driving at, Dr. Clark—

THE COURT: That is all right, if you have a substance that has already been identified, and you are simply—you don't know what it is—and you are trying to check up to see whether it is any of the things that have been analyzed or which are known, but he wants to know if you do that if you are looking for a substance that nobody has identified before?

DR. DAVEY: That is exactly what we are trying to show. There is no magic in this. What we are trying to get the witness to give an opinion on is whether if you have no diffraction pattern corresponding to this unknown substance, unless it is known quantitatively, could you, just by looking at the diffraction pattern, tell what the chemical composition of that substance is, or does it depend on coincidence—

THE COURT: As I understand it, this is what Dr. Davey has asked you, and I think that a whole lot of this passes in our everyday experience. Am I right or wrong when I say I understand that you have arrived at certain lines which, generally speaking, correspond with Ferrari's lines, and in addition to that you have called the whole process and the method by which your analysis was obtained, and the reaction you got—in other words, the history of the product itself, and the various mechanics which you brought to bear on it, that you have used, and you have come to the conclu-

sion that it is  $Pb_2O$ , is that the result of your work?

THE WITNESS: Yes.

By THE COURT:

Q. Then, I guess what Dr. Davey wants to know is whether you took Ferrari's pattern and superimposed it or put it side by side with your pattern, or whether you shouldn't have done it?

A. Dr. Davey spoke of actually taking a substance, making a pattern of it.

Q. Yes.

A. A known substance.

Q. Yes.

A. And, of course, we have made the comparison, and in these sheets we have submitted calculations of  $Cu_2O$ ,  $Ag_2O$ , both of which are—they both have cuprous structures.

THE COURT: I don't know whether that will be complete or not.

DR. DAVEY: Can you get from X-ray data alone any information as to the chemical identity of the material if he has no record of the diffraction pattern of the chemically known material which will be made to coincide with it?

THE COURT: Can you answer that question? Is that question a fair question?

THE WITNESS: The only answer to that is to run  $Pb_2O$  against  $Pb_2O$ .

THE COURT: That is the way it seemed to me.

By MR. WHITCOMB:

Q. What about your oxalate methods?

A. We have obtained a product from oxalate decomposition which has been compared. It is not mixed in with the rest, but it is compared for results and measurements.

By MR. MORRIS:

Q. Would you know any more with your oxalate experiment that you had  $Pb_2O$  than you would with your lines, or, that the lines you got with your oxalate, you could say that those were  $Pb_2O$  any more than you can say that the lines you got in nine, ten and eleven were  $Pb_2O$ ? We are speaking now of the chemical composition, as I understand it,  $Pb_2O$ ?

A. Yes.

Q. However, at least until you made your experiments recently, there was no isolated  $Pb_2O$  in the world was there?

A. That's right.

THE COURT: Doesn't it follow that Dr. Davy's questions really defeat themselves if the thing has not ever been done? You cannot identify any substance that way. You couldn't make the discovery.

MR. MORRIS: But the lines do not constitute a chemical analysis.

THE COURT: No.

MR. MORRIS: We are speaking of  $Pb_2O$ .

THE COURT: Dr. Clark says that is a substance you cannot reach by chemical analysis, or, nobody can reach it, but that does not mean it does not exist.

MR. MORRIS: The question is whether the X-ray can tell you, or, does tell you without any

standard by which to compare it with a known chemical, say,  $\text{Pb}_2\text{O}$ , that you can say that it is a  $\text{Pb}_2\text{O}$  substance that you have.

THE COURT: Yes, that is all right.

THE WITNESS: There are—we have the direct analysis of it in our  $\text{Cu}_2\text{O}$  and  $\text{Ag}_2\text{O}$ , and the analogy of the structure as we derive it from this new substance.

By MR. MORRIS:

Q. You reach a conclusion then as to the chemical composition of these lines, not by a diffraction pattern of this substance alone, but by their relationship to certain other unlike chemicals, but analogous chemicals?

A. That is part of it, and compared with this as a method of chemical analysis, the X-ray certainly tells us that here is a given crystalline structure, and that that crystalline structure is similar or analogous to that which is, well, known as  $\text{Cu}_2\text{O}$  and  $\text{Ag}_2\text{O}$ . Then, we may add to that by any experiments which might be made to indicate the behavior of the substance, change it in any way we can to throw light upon its action.

Q. State the technical term which crystal analysts apply to the powder-method diffraction pattern of chemical element having a face-centered cubic structure?

A. Would you please ask that again, please?

Q. What is the technical term which crystal analysts apply to the powder-method diffraction pattern of chemical element having a face-centered cubic structure? What is the diffraction pattern of a face-centered cubic structure called? Is it face-centered cubic type of diffraction pattern?

A. Yes.

Q. Is this same technical term applied to powder-method diffraction pattern of similar type irrespective of the crystal structure or chemical composition of the substance giving the diffraction pattern?

A. Crystals are classified as they are, for example, in Wyckoff's book, and there is a tremendous variation in the structures, under certain classifications and under certain types, of which there are now a large number, and under any given type of crystal structure we may have, we have actual representatives, for example, in the face-centered cubic type, we may remember, there is silver and gold, they are of the face-centered type. They are, and so are copper, of the face-centered type.

Q. If I understand you, this term is applied, that is the term face-centered cubic type of diffraction pattern is applied to the powder-method diffraction pattern?

A. Yes, sir.

Q. Of similar type?

A. Yes.

Q. Without regard to the crystal structure or chemical composition of the substance giving such face-centered cubic type of diffraction. Am I right?

A. Crystal structures may—it must be face-centered cubic in order to be classified as belonging to the face-centered type.

Q. Will sodium iodide number one give a face-centered cubic diffraction pattern?

A. Sodium iodide at first glance may either change to actual simple cubic, or the appearance is face-centered type, depending on whether the iodides are heavier than the sodiums.

Q. What you mean by that is that the iodides are brought up heavier in the periodic table?

A. Yes, and of course you have the diffracting standard powders. If we look at the simple cubic lattice, we will see that there are two interpenetrating lines, one of iodide and one of sodium. The iodide will outweigh the sodium line in intensity.

Q. Will you give me the ordinary types of diffraction patterns for crystals belong to the cubic system? Are they, one, simple cubic type of diffraction pattern, two, body-centered cubic type of diffraction, three, face-centered cubic type of diffraction pattern and four, diamond cubic type of diffraction pattern?

A. Yes.

Q. Do these technical terms per se, applied to describe types of diffraction patterns, necessarily imply anything as to the type of crystal structure of a given substance which gives rise to one of these types of diffraction pattern?

A. Well, if we say that a substance has a diamond type of structure, why, that means, of course, incidentally that it is constructed, its crystal structure is analogous to that of pure diamond and belongs to the diamond cubic type.

Q. Does the term itself, for instance, the body-centered cubic type of diffraction pattern necessarily imply anything as to the type of the crystal structure of a given substance?

A. Well, body-centered type is a crystal structure type.

Q. That is, a body-centered cubic type of diffraction pattern means you have a body-centered crystal structure of the substance of which you are seeking the pattern?

A. Yes, has a body-centered type of structure and type of pattern?

Q. Well, do the intensities of the lines have anything to do with interpreting the diffraction pattern?

A. They do, especially in the ultimate analysis in which all positions of the parameter in space are accurately placed.

Q. Is the crystal structure of any substance determined by means of a systematic interpretation of the diffraction pattern?

A. It is.

Q. Does the interpretation take into account both the type of diffraction pattern and the relative intensities of the lines in the diffraction pattern?

A. If we have a single pure substance, then, of course, the pattern of the lines and the intensities which of course are subject to certain conditions and certain variations, both are involved in that interpretation, especially, as I say, if we proceed in the analysis clear through just as far as it is possible to go, to the space group and all parameters in space, or every single atom in the unit cell.

Q. You gave me the number, I think it was four, of ordinary types of diffraction patterns. Will you give me the four most common types of crystal structure? Types of crystal structure in the cubic system?

A. You want those repeated?

Q. No, what I have in mind is I have been advised that the ordinary types of diffraction patterns or crystals belong to the cubic system are the simple cubic type of diffraction pattern, the body-centered cubic type of diffraction pattern, the face-centered type of diffraction pattern and the diamond cubic type of diffraction pattern?

A. Yes.

Q. That is correct?

A. Yes, that is what I said a while ago.

Q. Will you state the technique of interpreting powder-method diffraction patterns? Since the sodium halides, that is,  $\text{NaF}$ ,  $\text{NaCl}$ ,  $\text{NaBr}$ ,  $\text{NaI}$ , are used as typical examples in some of the books which have



been mentioned. Will you please use them as concrete examples in giving your answer?

A. Of these, three of the four substances, the patterns for sodium chloride, sodium barium and sodium iodide will appear to be very similar, first the lines displace in connection with the increasing sight of halide ion, and the first impression one gets from such a pattern is that of a face-centered sodium bromide, on the order, just as the Rubidium chloride gives a pattern which has all the characteristics we would say of a simple cubic lattice, where all of the distances can be calculated by dividing the lattice by the square root of the sums of the squares of the indices.

The face-centered lattice, of course, is distinguished, that is, the pure face-centered lattice is distinguished by the absence of certain possible lines, by the centered absence of definite lines. Sometimes it is not possible without the data from a single crystal, to interpret correctly or entirely uniquely the finely complicated crystal structures of some kind. In these particular cases we find from the measurement of the lines the correlation, micromatic correlation or relationship that is shown in the spectogram, so that they represent two interpenetrating center-faced cubic lattices, and sodium fluorine ions have precisely the same scattering powders, those two interpenetrating lines will give you a different appearing specter from the other three. The lines can be measured.

Q. I am wondering whether sodium chloride gives a simple cubic type of pattern when only the strong lines are considered, but that there are, besides, very weak lines which, when taken into account, transform the pattern into that of a face-centered cubic type. I am wondering if I am correctly informed about that. I mean NaF, instead of NaCl?

A. Every line of any F will give you a simple

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type of lattice, because we have fluorine ions in the one, one, one planes interspersed between two sodium planes, and acting exactly like a sodium plane.

Q. Let me see if I am right in my assumption that NaF gives a simple cubic type of pattern when only the strong lines are considered. I am right so far, am I not, that NaF gives a simple cubic type of pattern when only the strong lines are considered?

MR. WHITCOMB: Your Honor, I don't think he is going to remember everything without any information. Furthermore, do you want to suggest that maybe there should be some limit?

THE COURT: I don't know how much of this material is going to get into the pan. That is where it has to get, it has got to be fractionated many, many times.

MR. MORRIS: I think, if the court please, he has come to a definite—

THE COURT: I won't interfere.

MR. MORRIS: If you want any of your books—

THE COURT: I won't interfere. It would be presumptuous to suggest anything about this testimony.

By MR. MORRIS:

Q. Dr. Clark, perhaps you would rather I deal with NaCl. I am perfectly willing. It is more common, isn't it?

A. Yes.

Q. Suppose we pass to NaCl. The weaker lines of NaCl are somewhat stronger. I am advised than in the case of NaS, but they are still so weak that the simple cubic type of patterns can be picked out easily from the diffraction pattern?

A. That's right.

Q. As far as NaBr the weak lines are still stronger, as I am advised, so that the face-centered cubic type of diffraction pattern is quite marked?

A. Yes. NaF, I might say, like NaCl, all have lines that enter into the pattern.

Q. Let me see if we agree about NaF at the moment. If you want some reference, I don't think you will, Dr. Clark, but if you do, it is perfectly all right. My information here is that NaF gives a simple cubic type of pattern when only the strong lines are considered, but that, there are, besides, very weak lines which, when taken into account, transform the pattern into that of a face-centered cubic type. Is that right?

A. Well, I don't think so for sodium bromine.

Q. You don't think it is true of sodium bromine?

A. No.

Q. The first part you nodded, but did not say yes. You agree that sodium fluorine gives a simple cubic type of pattern when only the strong lines are considered?

A. When all the lines are considered.

Q. When all the lines are considered?

A. Sodium fluorine gives you a series of simple cubic strong lines.

Q. And no weak lines?

A. Not unless it is a beta line or something of that sort.

(Discussion off the record.)

By Mr. MORRIS:

Q. Let us withdraw that question about sodium fluorine. The sodium iodide, the pattern is clearly that of the face-centered cubic type, both for the rela-

tive positions of the lines and for their relative intensities?

A. Yes, iodide outweighs the sodium.

Q. As shown in the periodic table?

A. Yes.

Q. I am advised that what you have said with regard to sodium compounds is explained by assuming that both the sodium and the halogen each lie on face-centered cubic lattices which attempt to dispatch X-rays independently of each other, each with an intensity which depends largely upon the ionic number of of the ion. All right so far, am I?

A. That is correct.

Q. Thus, since Na plus, and that is positive ions and F negative ions have the same ionic number and nearly the same ionic volume, they have nearly the same dispatching power?

A. That's right.

Q. Those lines in the pattern whose intensity depends upon the difference in dispatching power of the sodium positive ions and the F negative ions will therefore be very weak. All right?

A. Yes.

Q. And those which depend upon the sum will be strong?

A. Yes.

As the ionic number of the halogen ion, Cl negative ion, Br negative ion and the I negative ion, is increased the diffraction power of its face-centered cubic lattice is increased while that of the sodium positive ion remains the same. Right?

A. Yes.

Q. And the lines which depend on the differences in diffracting power become, therefore, less and less weakened while those which depend upon the sums are less noticeably strengthened. Is that right?

A. Yes.

Q. In this way a series of crystalline compounds of identical type of structure gives diffraction patterns which are of quite different type. Is that right?

A. Please read that first part there again.

Q. In this way?

A. Next.

THE COURT: Read the whole question.

By Mr. Morris:

Q. In this way a series of crystalline compounds of identical type of structure gives diffraction patterns which are of quite different type?

A. I should say that there is fundamentally a difference in the type between sodium chloride, bromide and iodide. It is progressive, but the actual pattern I would not say is fundamentally different. There is a progression, there is a change in relative intensity, it is true, but the patterns themselves are certainly analogous.

Q. Many diffraction patterns which are of quite different type may lead, when properly interpreted, to identical types of crystal structure?

A. Well, of course, we couldn't take a pattern which gave exclusively a face-centered type of lattice, and from that say that it is simple cubic. You could never say that lead or gold or something of that sort crystallizes like sodium chloride, although the lines are face-centered cubic. That is, there are peculiarities which come in which are real clues and—

Q. Well—

(Discussion off the record.)

THE COURT: Let us have the answer.

MR. MORRIS: Yes.

THE COURT: Read the question:

(The question was repeated by the reporter as follows:—

“Q. Many diffraction patterns which are of quite different type may lead, when properly interpreted, to identical types of crystal structure?”)

By MR. MORRIS:

Q. For instance, sodium chloride gives a simple cubic type of pattern and sodium iodide gives a face-centered cubic type of pattern?

A. Well, sodium chloride of course gives the strong lines of the simple cubic, but there are some faint lines.

Q. You are dealing with NaCl instead of KCl.

A. I thought you just asked about NaCl.

Q. It is KCl instead of NaCl.

A. KCl gives a purely simple type of pattern.

Q. While sodium iodide gives a face-centered cubic type of pattern, doesn't it?

A. Certainly. The lines, unless there be some very, very faint ones, are those of face-centered lattice, yes.

By THE COURT:

Q. Are those two identical crystal spectrums?

A. Both crystallize alike—

Q. Yes.

A. —as simple cubic.

Q. They are actually the same?

A. Yes.

By MR. MORRIS:

Q. I got the impression that there are no weak



lines in sodium iodide. I thought you said so a while ago?

A. I think perhaps Dr. Davey did. I can't remember now as to whether there were very faint lines or not. If there are, they are very faint, I know.

Q. Well, do you agree that the sodium iodide does give a face-centered cubic type of pattern, taking all the lines into consideration?

A. Sodium iodide gives the lines, excluding any very faint ones which I do want to leave, reserve there. It gives a pattern of the face-centered cubic.

Q. All right. Is the structure arrived at by the technique that we have just been discussing, subject to confirmation by showing that density, calculated from the crystal structure, agrees within the precision of the data with the density of a chemically identified specimen determined in the ordinary way?

A. That is a procedure which is of course very frequently used. The X-ray—intensities calculated from X-ray data gives you an idea value, since the X-ray pays no attention to tracks and voids. In a technique approaching the ideal value of densities, very often in crystal structure determinations the values are compared, and one piece of data or datum is compared with the other or confirmed by the other.

Q. You would need such confirmation for purposes of complete identification. I am asking you now as a scientist and not as a partisan, of course, Doctor?

A. I would say it would be very useful to have that data; perhaps not absolutely essential for identification.

Q. And in any case—

A. Well, I may say simply this, oftentimes there may be two alternative possibilities in interpretation, particularly in the selection of space groups. There, the densities are accurately made, and experi-

mental determination might help very much in distinguishing between two alternative possibilities, one which would call for two molecules per unit cell and the other for four molecules per unit cell or something like that.

Q. If there are two or more possibilities, the chemical determination would be essential to a definitely certain conclusion?

A. Well, not necessarily chemical analysis, but what I am speaking of is the X-ray data may not be able to distinguish between two closely allied space groups. There will be no mistake, unless—it is very, very rarely, at any rate—but, sometimes, particularly in complicated crystals, you may not be able to distinguish between one space group and another, or in particular molecular configuration, and then a comparison of the densities is then calculated on the one basis, with the actual experimental data, or a comparison of one, with the other.

Q. Dr. Clark, I am lost. That does not surprise me, but I am lost in it here, because what are you going to compare the data with respect to density with where you have two or more possibilities?

A. Well, the densities of course can be certain, if you have arrived at two space groups where one calls, let us say, for four molecular and the other for two, the densities from those two alternative bases can be calculated.

Q. You mean you can determine by mathematical calculation on an assumed hypothesis as to what those intensities should be and you would not need to compare the densities with the chemically identified specimen in order to be certain of your X-ray conclusion?

A. No, that is just what we do do. We compare the actual densities as determined with the spectrometer with the calculated ones.

Q. With the calculated ones?

A. Yes, calculated from the X-ray data.

Q. And then is that a prophesy or a determination of what the assumed material is?

A. Well, we have arrived from X-ray data to a certain unit cell, the volume of the unit cell can be known from the X-ray data, the true measurement the X-ray data gives us. Then, if you know the molecular weight of the substance under consideration, of course, the mass of this unit cell will be a number of measurements times the molecular weight times the absolute weight of the hypothetical item, and that gives us the absolute mass divided by the volume.

Q. Suppose you were looking at a powder-method X-ray diffraction pattern of a compound composed in the ratio of one to one or perhaps one to two, of two kinds of atoms, one kind being very light atoms such as hydrogen or oxygen, the other kind being very heavy atoms such as lead barium. Would the positions of the lines in the diffraction pattern depend on the arrangement, in the crystal, of the light atom or of the heavy atom?

A. Well, we could find, in any compound that has hydrogen in it directly, we could find the actual position. Hydrogen would then give us the measured scattering effect—

Q. How about the oxygen?

A. That being sixteen times as heavy as hydrogen, it will be six times as effective. It depends on what the oxygen is compared with.

Q. I am giving you lead barium, or a substance having a very atomic weight?

A. Yes.

Q. Now, would the position of the lines of the diffraction pattern depend on the arrangement of the heavy atoms?

A. It would depend upon the position of the heavy atoms, although we must understand that the position of those heavy atoms is determined, and the distance between them, but the diffraction part, gathering power of the lead is very much greater, and that will predominate.

Q. Assuming two kinds of atoms, one very light like hydrogen or oxygen and one very heavy like lead or barium would the intensities of the lines in the diffraction pattern be seriously affected by the presence of the light atoms? Seriously affected by the presence of the light atoms?

A. Well, other things being equal, not very much.

Q. What are the three types of crystal structure most usually found in the cubic system for crystals of compounds which are made up of equal numbers of each of two kinds of atoms?

A. The body-centered cubic of course is very familiar. The simple cubic such as sodium chloride and so on, and there are some compounds which crystallize.

By THE COURT:

Q. What does body-centered mean and face-centered?

A. You have a little tube, which is a lattice work. There, you have an atom at every corner of the tube, one on the center of the first one and on the center of every one of the six faces. On the body-centered tube you have seven corners, and you have an atom on each corner and one in the center. A simple tube would be simply an atom in each corner.

By MR. MORRIS:

Q. By your answer to my question would you include the zinc blende sphalerite cubic zinc sulphide type?

A. Yes.

Q. Now, then, will you describe the sodium chloride type of cubic structure?

A. The sodium chloride type is a simple tube made up of alternating sodium chloride, like this (indicating). This would be chloride, or sodium chloride, and the next little tube would be again chloride and so on.

By THE COURT:

Q. What is that?

A. A little principle of crystal chemistry showing this.

By MR. MORRIS:

Q. What type of powder-method diffraction pattern does the sodium chloride type of structure give in the general case where atoms A and B have unequal diffracting power?

A. That gives a predominantly face-centered type of lattice.

Q. Will you tell me about the zinc blende sphalerite cubic zinc sulphide? Does that consist of a two face-centered lattices, one of atoms A, the other of atoms B?

A. Let me see—that is essentially correct. I think the one face-centered lattice is displaced one-fourth of the way to the body diagonals, and the lattice, the other three-fourths.

Q. Do these two lattices have their cube-edges parallel, and the B lattice is so placed with respect to the A lattice that the atoms of B fall one-fourth and three-fourths the way along two of the body diagonals of this A lattice?

A. Yes.

Q. What type of powder-method diffraction does the zinc blende sphalerite cubic zinc sulphide type of

structure give in the general case where atoms A and B have unequal diffracting power?

A. Well, of course, we have a diamond type of structure, but the intensity of the distribution will be conditioned by the exact weight of the alternating zinc and sulphur atoms. Zinc, of course, is about twice as heavy as sulphur.

Q. Well, now, I am advised that that gives a powder-method diffraction pattern of a face-centered cubic type due to the face-centered cubic configuration of the atoms having the greater diffracting power. Is that correct?

A. The zinc is of a face-centered lattice, and the predominating structure of the lines correspond to it.

Q. Then my last question is correct, the statement in my last question is correct. What are the two types of crystal structure most usually found in the cubic system for crystals of compounds which are made of two kinds of atoms in the ratio of 1 to 2 or 2 to 1? My information is that the cuprite cuprous oxide structure and the fluorite calcium fluoride structure. Is that information correct?

A. Yes, I believe that's right.

Q. Describe the cuprite cuprous oxide type of structure? My information on that is, I will read it in the interest of expediting the examination. The cuprite cuprous oxide type of structure has a face-centered cubic lattice of A, of copper in the case of cuprite, with two atoms of B, of oxygen in the case of cuprite, situated on a single body-diagonal of the face-centered cube. One of these atoms of B is one-fourth the way along the body-diagonal—the other is three-fourths the way along that same body-diagonal. Strictly speaking, I have described one-eighth of the true unit of structure. The other seven cubes comprising the rest of the true unit differ from the one



I have described only in the choice of the body-diagonals, along which the atoms of B lie.

Is that correct?

A. Yes.

Q. What type of powder-method diffraction pattern does the cuprite cuprous oxide type of structure give in the general case where atoms B have less diffracting power than atoms A. I would be glad to read you what my information is on that.

A. Yes.

Q. In the general case in which atoms B have less diffracting power than atoms A the cuprite cuprous oxide type of structure gives a powder-method diffraction pattern of a face-centered cubic type, due to the face-centered cubic configuration of the atoms of

A. Correct?

A. Correct.

Q. My next question is to ask you to describe the fluorite calcium fluoride type of cubic structure. My information with regard to that is the fluorite calcium fluoride type of structure contains three face-centered cubic structures, one of atoms A and two of atoms B. The two of atoms B are placed in such a way that atoms of B come at points situated one-fourth and three-fourths the way along each body-diagonal of the cube of atoms A. Is that correct?

A. Yes.

Q. What type of powder-method diffraction pattern does the fluorite calcium fluoride type of structure give in the general case where atoms B have less diffracting power than atoms A?

My information is that in the general case where atoms B have less diffracting power than atoms A, the fluorite calcium fluoride type of structure gives a powder-method diffraction pattern of a face-centered cubic type because of the face-centered cubic configuration of the atoms of A.



Is my information correct?

A. Yes.

Q. Which of these four structures was supposed by Ferrari to explain the data which he obtained for his so-called  $\text{Pb}_2\text{O}$ ?

My information is, the last, namely the cuprite structure? Is that your information?

A. Yes.

Q. If a cubic crystal, composed of equal numbers of atoms A and B has the sodium chloride type of structure and if the A atoms are very heavy, like barium or lead, and if the B atoms are very light like oxygen, what type of X-ray powder-method diffraction pattern would be obtained?

My advice is, a face-centered cubic diffraction pattern corresponding to the configuration of the heavy atoms A would be obtained. Correct?

A. Yes, sir.

Q. If a cubic crystal, composed of equal numbers of atoms A and B has the zinc blende sphalerite cubic zinc sulphide type of structure and if the A atoms are very heavy, like barium or lead, and if the B atoms are very light like oxygen what type of powder-method X-ray pattern would be obtained?

My information is, a face-centered cubic diffraction pattern corresponding to the heavy atoms A?

A. Yes, sir.

Q. If a cubic crystal, composed of two atoms of a heavy element A for every atom of a light element B, has the cuprite cuprous oxide type of structure, what type of powder-method diffraction would be obtained?

My advice is, a face-centered cubic diffraction pattern corresponding to the configuration of the heavy atoms A?

A. Yes, sir, that is essentially right.

Q. If a cubic crystal composed of one atom of a very heavy element A and two atoms of a very light element B has the fluorite calcium fluoride type of structure, what type of powder-method diffraction pattern would be obtained?

My advice is that a face-centered cubic diffraction pattern corresponding to the configuration of the heavy atoms of A.

Is my information correct?

A. Yes.

Q. All four of these types of structures (sodium chloride, zinc blende, cuprite, and fluorite) give identically the same type of diffraction pattern if atom A is heavy with respect to atom B, do they not?

My information is that they do. Correct?

A. Yes.

Q. And if the atoms of A are very heavy with respect to the atoms of B, the diffracting power of the atoms of B will be negligibly small in comparison with that of the atoms of A, that is correct, is it not?

A. Yes.

Q. So that in all four hypothetical cases which you have just discussed, if atom A is very heavy with respect to atom B, the powder-method diffraction patterns will not only be of the same type but will have substantially the same intensities of lines?

A. Yes, in general, that's right.

Q. In the atomic weight, or, if you choose, the atomic number of oxygen is very low, is it not?

A. Yes.

Q. The atomic weight, or if you choose, the atomic number of lead is very low, is it not?

A. The atomic number, yes, sir.

Q. Then, if you were given a lead-and-oxygen compound of unknown composition, and if you found that it gave a face-centered cubic type of diffraction

pattern, you could not tell from the diffraction pattern alone whether the compound had the sodium chloride, the zinc blende, the cuprite, or the fluorite type of structure, could you?

The information I have is that you could not. Is that correct?

A. If you had just that data and nothing else, I suppose not.

Q. What other data would you—what other data would make your answer comply?

A. If you had any idea of the atomic dimensions, that would be helpful.

Q. In the specific case of a lead and oxygen compound giving a face-centered cubic type of diffraction pattern you could not tell from the X-ray data alone whether or not you had a cubic form of  $\text{PbO}$  or a cubic form of  $\text{PbO}_2$  or a cubic form of so-called  $\text{Pb}_2\text{O}$ , if such exists, could you?

THE COURT: What was that question?

By M. MORRIS:

Q. In the specific case of a lead and oxygen compound giving a face-centered cubic type of diffraction pattern you could not tell from the X-ray data alone whether or not you had a cubic form of  $\text{PbO}$  or a cubic form of  $\text{PbO}_2$  or a cubic form of so-called  $\text{Pb}_2\text{O}$ , if such exists, could you?

A. If such exists, is one matter, but however, the lattice constant atoms would be different, even if it gave the face-centered cubic lattice in all cases, the lattice constant would be distinctly different for those three.

Q. Meaning thereby—

A. That is the distance between the lead atom depending on the number of oxygen in between, and the area of the oxygen, and so on.

By THE COURT:

Q. Is that the A subzero you were talking about?

A. Yes.

Q. What other data would be necessary to supplement the X-ray diffraction data in order that the unknown substance may be properly identified?

THE COURT: Have you said that it could not be properly and completely identified by the X-ray alone? The judge assumes that that is your answer, but was your answer quite that?

THE WITNESS: I would certainly place very high, if not first on any list, for purposes of identification of unknown substances, the X-ray results.

By MR. MORRIS:

Q. That is above chemical results?

A. Well, chemical results, if they could be obtained very accurately would certainly be very helpful in case there would be no information about the pure compound, no information about the actual number of atoms, or which kind they were, or the actual formula, the molecular weight and so on. That is, of course, the first essential.

Q. The ionic dimensions?

A. The ionic dimensions, yes.

Q. How much help would the ionic dimensions give you?

A. Those ionic dimensions are very frequently used for measuring the packing within the given volume, for example, if a volume—if you arrived at certain results, or think you have reached a certain result, that may be entirely incompatible with the packing in the given volume of a certain number of atoms.

unless those atoms are subjected to some very peculiar distorting force of some kind.

Q. If you were using the ionic dimensions, I assume that the authorities agree with regard to such dimensions, or am I wrong about that?

A. They were not constant under all conditions.  
Dr. Davey—

Q. Then you would have set from Bragg, and one from Dr. Davey, and another from somebody else?

A. There has been no set of constants set up for any ionic measurements. We are coming along, and this thing should give you a very good rough idea.

Q. That being true, will you select Davey or Bragg or somebody else's way to test the ionic dimensions? It wouldn't make any difference which you selected because it would be subjecting your yardstick to such a constant source—

A. Yes, that's right.

Q. I am right, am I not?

A. Yes.

Q. So that again you would be using an electric yardstick in determining the existence of this assumed newly discovered compound. You wouldn't be very sure of yourself, Dr. Davey, if you were using such a yardstick as that?

A. That is true, it is only for the reference.

Q. Did Ferrari make a quantitative chemical analysis of his material to show that it was  $\text{Pb}_2\text{O}$ ?

A. I believe he did, yes.

Q. If you can find out, I wish you would show it to me because I have been looking for it, and I thought it wasn't shown. I thought he also had impure material?

A. That is true, there is no question about that.

Q. Dr. Davey calls my attention to the fact that I called you Dr. Davey. I am not sure whether you

may like it, but, may I apologize and call you Dr. Clark?

A. I am highly honored. We have been friends for many years. This notation reads, "It appears very probably that the first product was the suboxide in question. The analysis of the product shows, the lead being determined as sulphate. The lead content is less than that calculated for  $Pb_2O$ . In one hundred parts, lead found 93.83 calculated for  $Pb_2O$  96.40, for  $PbO$  92.82."

Q. He does use the term "calculated as  $Pb_2O$ ?"

A. Yes.

Q. And you knew Mr. Ferrari had been able to repeat his experiment?

A. I don't know.

Q. You have not been advised that he has been able to repeat it?

A. No, I think two years ago I had a very brief correspondence with him in which he simply stated he maintained his stand.

Q. You would not base your professional reputation on his test alone, would you, Dr. Clark?

A. Not on his test alone, no.

Q. As far as you know he never made but one?

A. Just what do you mean by test?

Q. Well, I am speaking of Ferrari now?

A. Yes.

Q. And his publication, as far as you and I know, we know he didn't repeat the test or experiment, as far as you and I know? He never made but one?

A. That is all I know about it.

Q. You would not bank or bet very much on such an experiment?

A. No, not very likely.

By THE COURT:

Q. He did, didn't he?

A. Yes, he did.

By MR. MORRIS:

Q. I am wondering how much you predicate your conclusion on that one of Ferrari's? Would you mind telling us?

A. I will tell you, Judge Morris, when I—as I said—I started from zero on this. I experimented with this, and when these same lines began to appear, they didn't seem of very much consequence, but, just then, after the results piled up, and I started to make certain comparisons of lines, and things which I have lived with continuously through about four years of striving to get a purer product so that I would be sure—

Q. Were you remaining wholly impartial in your attitude, or were you working for plaintiffs during that four years?

A. No, this work on this sort of thing began in my laboratory purely as an experimental problem. It was commenced before any connection with plaintiffs.

Q. Did you ever find anything that gave you really any encouragement for your  $Pb_2O$  line until the last two months say?

A. No, I felt from the completion of the results, I am perfectly willing to admit, I felt that this one sample would be compatible with Ferrari's, but when this experiment was completed, the crucial moment came when this pattern was produced free from lead and free from  $PbO$ , I felt that my work was complete, and I feel, for myself, sure of what I have found.

Q. Now, then, I would like to ask you a little about this experiment on Monday morning, if I may?

By THE COURT:

Q. I want to get an idea of how you started on this



work. Did you start out with the idea of ascertaining the existence of  $Pb_2O$  four years ago?

A. Yes, that was partly in the picture. I have, of course, a large number of students doing X-ray work, and when this controversy came out in the literature, we were interested in the qualitative analysis and various chemical purposes. I just happened to come across it, and it seemed to be more a problem we assume independently, because of the conflict between the two men.

Q. What two men?

A. Van Arakel and Ferrari.

Q. At that time were you advised of the commercial setting of this thing at all?

A. Not until some period later. We, of course, differ—

Q. For instance, when you started that, did you know anything about how lead powder was used in storage batteries?

A. Only in a very indirect way. We have become interested in the whole chemistry of the storage batteries, and if we can find out something about them with this method that is the thing.

Q. Well, I mean four years ago?

A. No, the thing simply began purely as an inorganic chemistry problem.

Q. Four years ago did you know how plates of a storage battery were made?

A. Just as we would teach a chemistry student, that's all.

Q. You didn't know how they were made?

A. Yes.

Q. You did know they were made of paste and lead powder and so forth?

A. Yes.

THE COURT: I just wanted to get a general

idea of where this fitted in with your general knowledge. All right.

(Adjourned to Monday, October 7, 1935, at 10:00 o'clock A. M.)

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GEORGE L. CLARK, recalled.

MR. MORRIS: I have no further questions of Dr. Clark.

*Re-direct-examination.*

By MR. WHITCOMB:

Q. I notice on some of those films you have introduced, particular those showing the illustration of the suboxide, I believe you have referred to around a 2.61 line, or something like that, —

A. Yes.

Q. —that it is a little wider, it seems wide to you compared with some of the others. Will you please go ahead in your own way and explain to the Court what in your opinion all that means?

A. Yes. The other day we were speaking in some detail of face centered cubic lattices, and the fact that the cuprite type of lattice would give a face centered type of pattern. When, however, we come to notice the numerical data from our experiments on the films which we have done, which we have made, we find that there is not a perfect check of these data. For instance, on the sheet marked "Corrected and Revised Measurements of Spacings" we find that those numbers—

Q. Has that an exhibit number?

A. That is just a copy—those spacings do not fall accurately upon a face centered cubic type of pattern.

Professor Davey has a method of using a slide rule, where he turns the slide upside down, and with a face centered cubic lattice, for example, if we plot the first line opposite number three, then all the other spacings should fall opposite integers on the reverse slide.

Q. Is that slide rule method illustrated in Dr. Davey's book?

A. Yes, it is. Now, that worried me a good deal at first. The second number in the list for this so-called suboxide is 2.61. In the work of Ferrari, however, this value is 2.69. If that is multiplied by two that gives the 5.38 which we mentioned the other day.

Now, if we examine the microphotometer curves on various samples which we have prepared we find that this second spacing, 2.60, sometimes 2.61, sometimes 2.62, 3, 4, 5, up to 6, and I have never succeeded in getting it up to 2.69, but the average value, that is, the value which seems to be most predominant, is about 2.609 or 2.61.

Now, of course, that instantly suggests a variability, a variation in a product which is being formed in the system lead-oxygen, and if those numbers do not fall perfectly together, in the sense of a perfect face centered lattice, that it illustrates a peculiar type of, we might say for the moment, distortion. In the last film which was introduced, a filtered one, there is—

Q. Will you get that film?

A. The last exhibit.

MR. WHITCOMB: Would you mind if the witness picks it out?

THE COURT: Yes, sure.

By MR. WHITCOMB:

Q. Would you mind coming over?

A. It is the very last film in the exhibit.

Q. Will you come down this way?

A. Yes.

(The witness produced the film.)

By MR. WHITCOMB:

Q. And, by the way, does this film show that wide line that I mentioned on my first question?

A. Yes, this very strong, strongest line there, appears to have on its one side a whole lot of other lines very close together. It is very broad and diffuse. Now, with these calculations in a film like this the next situation is one of trying to explain such a state of affairs. Of course, there are, I think a good many evidences among X-ray people of patterns in which lines are shifted. For example, in the paper by Le Blanc and Eberius, upon the existence of lead suboxide  $Pb_2O$ , we find two spectra from his work in which the lines, some of them, are considerably shifted one from the other, that is, a  $PbO$  tetragonal lattice, and then his material which he obtained by the decomposition of lead oxalate.

In the Ferrari paper the thing that interested me most is this:

"The diameter of lead which is calculated from the reticulum of the suboxide is instead of 3.36 . . . close enough to that of metallic lead 3.48 . . . to admit that the lead in this reticulum is in the metallic state and not that of the monovalent ion."

Now, taking that statement as it stands, of course, that would distinguish  $Pb_2O$  from  $Cu_2O$  and  $Ag_2O$ , where, of course, the ionic dimensions, even although they may be rough, are clearly those of an ionic copper and silver in an ionic state.

In 1932 there appeared in the "Zeitschrift Für Physikalische Chemie", volume 160, page 69, a paper which has the German title "Untersuchungen über Bleioxyde und deren Systeme mit Sauerstoff"—researches on lead oxides and their systems with oxygen—by Le Blanc and Eberius. Le Blanc, of course, is a very, very prominent chemist, whose reputation has been long established. This in many respects is one of the most remarkable papers ever published, a paper about forty pages long, and because of the length of it I will read the abstract of this paper as it appeared in Chemical Abstracts:—

"There are two forms of  $\text{PbO}$ , a red form stable below 585 degrees, and a yellow form stable above. The rate of transformation, yellow to red, at room temperature depends on the mode of preparation, and is increased by the application of pressure. Between 200 and 390 degrees both forms take up oxygen without the appearance of a second solid phase, until the composition reaches  $\text{PbO}_{1.7}$ —sub 1.7. "The original lattice"—that is, the tetragonal red  $\text{PbO}$  lattice—"persists up to about  $\text{PbO}_{1.13}$ , when it is replaced by a lattice that is different from any of those hitherto observed in the system lead-oxygen, and is identified with a dark colored modification of  $\text{Pb}_2\text{O}_3$ ."

Incidentally, if I may divert for a moment, this process was patented in Germany in 1933, and this new compound made by this method is now being manufactured under German patents for the purpose of pigments, a black form of  $\text{Pb}_2\text{O}_3$ .

"From  $\text{PbO}_{1.33}$ —sub 1.33—"the absorption of oxygen is reversible, and the form of the lattice unchanged"—the form of the lattice, un-

changed—"the pressure curve shows no discontinuity at the composition  $\text{Pb}_2\text{O}_3$ . When oxygen is removed the pressure falls continuously until  $\text{PbO}_{1.33}$  is reached, when  $\text{PbO}$  appears as a second solid phase and the pressure becomes constant. If a solid phase between  $\text{PbO}_{1.33}$  and  $\text{PbO}_{1.66}$ "—which means, of course, a continuous series,  $\text{PbO}_{1.33}$ ,  $\text{PbO}_{1.34}$ ,  $35$ , and so on—is heated above 389 degrees it gives off oxygen and forms ordinary red  $\text{Pb}_3\text{O}_4$ , which cannot take up an excess of oxygen. The transformation black to red  $\text{Pb}_3\text{O}_4$  is monotropic. When oxygen is removed from  $\text{PbO}_2$  by heating at a fixed temperature the  $\text{PbO}_2$  lattice"—that is, lead peroxide—"persists until the composition is about  $\text{PbO}_{1.66}$ , when it is replaced by the lattice of black  $\text{Pb}_3\text{O}_4$ . Since further the pressure curve is continuous there is no reason to believe that a compound  $\text{Pb}_2\text{O}_3$  exists. The loss of oxygen up to  $\text{PbO}_{1.66}$  is irreversible, and  $\text{PbO}_2$  cannot take up an excess of oxygen."

In other words, when you reach  $\text{PbO}_2$  no more oxygen will go into it.

"Oxides from  $\text{PbO}$ "—that is, Pb one, O one—"to  $\text{PbO}_{1.10}$  dissolve in nitric acid, those between  $\text{PbO}_{1.12}$  and  $\text{PbO}_{1.4}$  leave a residue of dark  $\text{PbO}_{1.66}$ ".

Now, the significance of this article. I have examined it many times. I cannot see any experimental flaw in it anywhere, every compound has been analyzed both for lead and for oxygen in the system, there has been complete X-ray work upon the whole system, and it indicates, contrary to the shades of John Dalton, that we have a unique situation in the system lead-

oxygen, in other words, that oxygen is taken up continuously, clear up to  $\text{PbO}_2$ , with these various peculiar conditions, that is, the transformation from one lattice form to the other, as have been briefly indicated here.

Now, the only other type of material that does this same sort of thing, apparently are some experiments on cobalt oxides, which give somewhat analogous results, in the sense that the absorption of oxygen is continuous. Now, this particular paper starts with  $\text{PbO}$ , pure  $\text{PbO}$  obtained by vacuum methods, of course, so that there would be no excess of oxygen. Then the pure  $\text{PbO}$  is submitted to the effect of oxygen gas, with these results.

Now, we have in our X-ray studies an example of one substance entering the lattice of another, producing a distortion. It is a field that is comparatively new yet, it is a difficult one, but if we take the case of Martensite, which is the component in steel, of hardened steel, which carbon combines with alpha iron continuously, over a whole range of compositions, producing a distortion in the original cubic lattice, and giving a whole successive range of tetragonal lattices, one right after the other, as we take a chunk of iron and put it into a carbon atmosphere, you have a complete variation in the amount of carbon in the X-ray spectrum and everything else, from the outside, where the carbon concentration has been a maximum, inward into the solid, into the solid metal.

Now, therefore, to make the thing as brief as possible, we have found certain peculiar variations and a certain continuity in the uptake of oxygen by metallic lead. In these particular mill samples, there is apparently a type, a peculiar type of distortion of the lattice, which retains fairly well the general form of a face centered cubic lattice, but it is slightly distorted



in the fact that this 2.6 spacing lags a little bit behind some of the other spacings as oxygen enters. Now, if that is true, therefore, if metallic lead takes up oxygen continuously, just as it does, certainly, through these oxides clear up to  $\text{PbO}_2$ , then it follows that we may have a range, a whole range of face centered cubic lattices from pure lead on up to  $\text{Pb}_2\text{O}$ , or somewhere between  $\text{Pb}_2\text{O}$  and  $\text{PbO}$ , or a transformation from a face centered cubic lattice, either distorted or not distorted, takes place to the tetragonal type. Now, therefore, a suboxide of lead can just as well be Pb one million O—

By MR. WHITCOMB:

Q. That is Pb sub one million?

A. Sub one million.

Q. Capital O?

A. Capital O: Pb one thousand O, Pb one hundred,  $\text{Pb}_3\text{O}$ ,  $\text{Pb}_2\text{O}$ ,  $\text{Pb}_2\text{O}_{.05}$ , with a continuous—with a continual uptake of oxygen and suboxide—a face centered cubic lattice, distorted or not.

Q. Now, in the patent in suit, the patents in suit, the patentee uses the term "suboxide", is that right?

A. He uses, in all of the claims the word is written out, lead suboxide.

Q. And your point is that does not need to be technically absolutely  $\text{Pb}_2\text{O}$ , but might be one of these others?

A. As long as metallic lead begins to take up oxygen and takes up oxygen continuously over a whole range of contents, just as I have tried to make clear in the theory from the beginning, that the original thing with the absorbed oxygen layer is for oxygen to enter the face centered lattice, and if one oxygen atom enters the face centered cubic lattice, so little, in fact, that you cannot distinguish the X-ray pattern at all

from metallic lead, still, if that oxygen is in that lead lattice, it is a suboxide of lead.

Q. And you believe that you have found that in these samples that you have taken of the Exide mill, and Prest-O-Lite, and so on?

A. Yes.

Q. Then could you express the chemical formula for what you think suboxide means?

A. Lead suboxide is a taking up by a face centered lattice of lead of oxygen in contents, any content or ratio of lead to oxygen such that the ratio of lead to oxygen shall be greater than one to one, in other words, two to one, three to one, ten to one, and so on.

Q. And just one more question.—

By THE COURT:

Q. Would that refer to a case like  $Pb_3O_2$ ?

A.  $Pb_3$ —yes, just so the ratio is more—

Q. That would be within your definition?

A. —than one to one, yes.

By MR. WHITCOMB: •

Q. And what is the total import of this redirect testimony, then, from your point of view?

A. Well, I feel simply this, that with the experimental background which we have it is perfectly fair to say that the study of distorted lattices, these so-called solid solutions with X-rays, is a difficult one, it explains why the lines have been so broad and faint, and yet it comes, it seems to me that it covers within the entire range of possibilities that if oxygen is taken up in this continuous or more or less continuous fashion by metallic lead, starting with a very high ratio of lead to oxygen, clear up to the place where  $PbO$  ensues, now, it is entirely possible, we don't know that, but it is entirely possible by analogy with  $PbO_2$ ,  $PbO$ .

takes up its characteristic lattice form at  $\text{PbO}_{1.66}$ , it is entirely possible that tetragonal lattice might take up its rearrangement or its form at something, a ratio a little on the lead side, under one to one.

Q. That is, you mean by the tetragonal,  $\text{PbO}$ ?

A. Yes.

Q. On your cross-examination you discussed certain crystalline compounds. Were there four of them, do you remember the ones?

A. You mean ones that had—

Q. Similar—

A. —face centered cubic—

Q. Yes.

A. —lattices.

Q. Or was it three? What were they, do you remember?

A. Well, they were of four compounds that would give a face centered lattice, such as  $\text{CaF}_2$ , and, let's see, calcium fluoride, and cuprite,  $\text{Cu}_2\text{O}$ , and sodium iodide—I have forgotten what the other one is.

Q. What is that blend?

A. Zinc blend, yes.

Q. In your opinion is there any possibility whatsoever of any of those substances having been in this material you tested, knowing—

A. None—

Q. —what you start—

A. —of those combined with oxygen or vary in any way. We are in a range of lattice dimensions here which distinguishes a metallic lead lattice, which is taking up oxygen.

Q. Then in your opinion those distances you measured eliminate any possible conflict with those other lattice-works, is that right?

A. Why, yes, that is, calcium fluoride does not take up oxygen, nor does sodium iodide, or anything of that kind in this variable manner, so far as we know.

Q. Now, those were four, I believe. How many possible substances are there that will take a crystalline form, anyway? Can you give the Court some idea?

A. Well, it would be hard to estimate the number of chemical compounds at the present time. It would be up into the hundreds of thousands, half a million or more.

Q. And of these, then, these are the only four that come within this form, in any event, is that right?

A. Yes.

Q. And as to those four that "a sub zero" line makes a complete differentiation, according to your testimony, is that right?

A. Well, of course, in dealing here with a variable, with a variable material, I have never succeeded in getting up to Ferrari's number 5.38, the nearest we can come to that is 5.33, but I think the distinguishing feature is the evidence of a lattice distortion and of a variability in the system Pb-O, just depending upon the particular way in which we happen to get the specimen.

Q. There is one other question, when the lead takes on the oxygen when would you say the crystalline structure takes on form PbO?

A. Well, there is no experimental data upon that at the present time. I just mentioned a while ago by analogy with PbO<sub>2</sub>, which is, I think, undoubtedly correct,—

By THE COURT:

Q. Well, that is just repeating what you said?

A. Yes, same thing.

THE COURT: I understood, at least, I think I understood it.

MR. WHITCOMB: I think that is all.

*Re-cross-examination.*

By MR. MORRIS:

Q. If I understand you aright, now, Dr. Clark, you are explaining by your testimony this morning why you do not have  $\text{Pb}_2\text{O}$ ?

A. We have  $\text{Pb}_2\text{O}$  as only one compound in an infinite series, practically.

Q. So if in your testimony during this trial so far you have said that you have, that Shimadzu had  $\text{Pb}_2\text{O}$ , and the defendant had  $\text{Pb}_2\text{O}$ , then you have picked out a single one, been able to pick out by your process and method a single one of an infinite series, and say that Ferrari had it, that Shimadzu had it, and that Electric Storage Battery had it, am I right?

A. There is present just as near to  $\text{Pb}_2\text{O}$  as—that is the most stable configuration, of that there wouldn't be any question.

Q. Now, since there is an infinite series and you haven't had any  $\text{Pb}_2\text{O}$  to analyze chemically, how do you know that this is  $\text{Pb}_2\text{O}$  that you have been referring to hitherto in this case?

A.  $\text{Pb}_2\text{O}$ , we approach a stable cuprite type of lattice, where you have—the configuration is such that there are two leads to one oxygen, we have a variation from that.

Q. Now, I gathered from your testimony this morning, Dr. Clark, that before you could have a cuprite structure or type of lattice that you must have a face centered cubic type of pattern?

A. Yes, exactly.

Q. And I gathered from your testimony this morning that you have now departed from that, and say that you do not have that, in that your lines, do not correspond with Ferrari's lines, and in that the measurements show a departure from the face centered type of cubic pattern. Am I right?

A. They depart in the sense that a slight distortion of the face centered cubic lattice occurs.

Q. Well, it either is or is not a face centered type of cubic lattice, and if I understood you aright, until this, until you took the stand this morning, you have never dealt with any distorted face centered type of cubic lattice, have you?

A. Nobody has ever inquired into these figures. We were just speaking in a perfectly idealized way.

Q. I know, but Dr. Clark, you were telling us that we had a face centered type of cubic lattice. Now, then, when we ask you about the figures you tell us, no, you don't have a face centered type of cubic lattice, you have something that approaches it. As I understand your testimony this morning, you have entirely shifted your position. Am I right?

A. I haven't shifted my position at all.

Q. Well, then, you—

A. I have just tried to explain it, or to amplify it, that is all. I have known this, of course, all the time, for months and months and months.

Q. It seems strange that you didn't tell us in the beginning, Dr. Clark, that you didn't have a face centered type of cubic lattice, but had something that approached it.

A. It is a face centered type of lattice, yes.

Q. When does a type of lattice depart from the face centered type, how much margin would you give it before it passes into some other type?

A. Well, until—until the essential pattern completely changes over in some other—

Q. Oh, then, you haven't the cuprite structure here at all, because that is truly a face centered one, isn't it?

A. Cuprite, yes, cuprite type of structure is a pure face centered type of lattice.

Q. And I read in Dr. Wilson's report that you had reported to him that you had a cuprite structure?

A. Cuprite type of structure, exactly.

Q. Now, then, you tell us this morning that you do not have that, but something that approaches it, am I right?

A. Well, that is right, yes.

MR. MORRIS: That is all.

*Re-direct-examination.*

By MR. WHITCOMB:

Q. Well, by that last answer you mean it is still that type, you stick to the—

A. Why, sure, it is a face centered type of lattice.

Q. But more or less distorted?

A. Yes.

Q. Then you rely on your original explanation of the lead first taking on the oxygen, and so on, changing—

A. Exactly.

Q. —over from one to the next, and finally, when it, as you say, takes a shape that could no longer be said to be a mere distortion, but it is an entirely new shape, then you get out of your type?

A. Yes.

MR. WHITCOMB: No further questions.

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RICHARD S. GARTON was called as a witness on behalf of the defendant and, having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

My first name is Richard, Richard S. Garton. I



am an employee of the defendant in this case. I have been for thirty-five years. The line of my duties is in charge of the Construction Department in the New York territory. These papers that you hand me are in connection with the work that I was in charge of at that time. I know that the batteries referred to in there were installed. I know that they were put into operation. I know about the date that the special positives were installed. That date was starting in February, 1917, and continuing for about three months, that is, special positives and special negatives. I remember the markings on those batteries or plates. The trays were marked B; the plates were marked I J B for the positives and I J I for the negatives. I knew that the batteries so made were used by the New York Railways.

(The following documents, offered by counsel for defendant were thereupon received in evidence and marked Defendant's Exhibit number 119:

"Photostat of letter dated December 1, 1916, from Manager of Construction Department to Mr. R. S. Garton; photostat of letter of December 2nd, 1916, from Manager of Construction Department to Mr. R. S. Garton; copy of letter dated December 11, 1916, from Manager Construction Department, to Mr. R. S. Garton; photostat of letter dated December 14, 1916, from Operating Department, Engineer-in-charge, to Mr. Welcke; copy of letter dated February 19, 1917, from Manager Construction Department to Mr. R. S. Garton; photostat of letter dated May 6, 1918, from Manager of Construction Department to Mr. R. S. Garton; copy of letter dated June 14th, 1918, from Manager of Construction Department to Mr. R.

S. Garton; photostat of letter dated June 13, 1918, from Operating Department to Mr. Hodge; copy of letter dated June 11, 1918, from Manager of Construction Department to Mr. R. S. Garton, and copy of letter dated June 3rd, 1918, from Department of D. and D. to Operating Department; Mr. Lesley.)

*Cross-examination.*

By MR. WHITCOMB:

I know what these papers are. They are in connection with the work that I was on. I got the originals from Philadelphia. I received all of these letters myself. There are none there written by me. I myself knew what material was in these special positives. I was located in New York City. I did not see the material go into the plates before they were formed in Philadelphia.

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J. LESTER WOODBRIDGE was called as a witness on behalf of defendant and, having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

My residence is in Philadelphia; occupation, Chief Engineer of the Electric Storage Battery Company. I have been such Chief Engineer for about thirty years.

I have had some experience in comparing technical documents one with another and processes one with another. Among my duties is the comparison of technical descriptions that appear in patents related to the business of the company, the preparation of brief ab-

tracts of those descriptions for filing in our technical library, the preparation of technical descriptions of processes and apparatus for use in preparation and prosecution of patent applications. Apart from my experience with the defendant, I had the following training: I was graduated from the Brooklyn Polytechnic, in 1884, with the degree of B. S.; from the Stevens Institute of Technology, in 1886, with a degree of Mechanical Engineering; and in 1923 the degree of Doctor of Engineering was conferred upon me by Stevens Institute.

I have read the patents in suit. I understand them except for certain ambiguities and contradictions which I do not think anybody can understand.

MR. WHITCOMB: I move to strike out the last part of the remark, Your Honor.

THE COURT: Well, no, he is called for his opinion. If he thinks the patents are unintelligible—

MR. BETTS: "Nobody can understand."

THE COURT:—in part he can say so. That is all right, that is a matter of opinion.

(Counsel for defendant here offered in evidence the following translations which were received in evidence and marked as indicated:

(Translation of Japanese patent number 41-728, to Genzo Shimadzu, was marked Defendant's Exhibit number 111.)

(Translation of Japanese patent number 42-563, to Genzo Shimadzu, was marked Defendant's Exhibit number 112.)

I have read the translations of those patents. I believe that I understand those patents.

MR. MORRIS: And I might add at this moment that it is stipulated and agreed by and between the respective parties that these translations are true and correct translations, subject to correction if error should appear.

MR. SCHAEFFER: That is correct.

The witness, resuming, testified: Comparing those patents, those translations, Exhibits 111 and 112, with the patent in suit number 149, Shimadzu Japanese patent 41728 describes a process for producing fine lead powder by placing pieces of metallic lead inside of a rotating vessel, rotating the vessel and grinding them to bits by means of the frictional rubbing of the lumps of lead on one another and on the inside of the walls of the vessel. The patent describes the process as follows:

"An iron cylinder 60 inches in diameter and 60 inches in length and which can be made to rotate is mounted horizontally and . . . lead balls having a diameter of one and one half inches thrown into it; then during the time it is rotated at about 25 revolutions per minute, the lead balls rub on one another—

THE COURT: Do you think it is necessary for the Doctor to read the patents? I mean, they are going to be in the record.

MR. MORRIS: May I make a statement with regard to that?

THE COURT: Sure.

MR. MORRIS: It is not necessary to read them, and I think counsel can perhaps do a great deal of this task in their field as counsel, but there is a question involved in these two cases, in these two

patents, and 149, and 150, and 151, and 479, and 020, where the question of lead dust comes in. Now, then, these two patents anticipate and destroy, as we see it, the whole field of the patents in suit, because it deals with lead dust in 41728 apparently as does the first claim of patent 149. The second patent, namely, Exhibit 112, injects air.

The date of the application of 111 was November 21st, 1920, and the patent issued February 13, 1922. No application was filed in America, under 4887, on either of these patents, which cover the whole field, so far as we can see, until long after twelve months had expired. These patents were applied for first, they were issued first, and Section 4887 of the Revised Statutes makes them a complete destroying power of all the suboxide patents by reason of the failure to file within that time.

THE COURT: Do either of these patents mention suboxide?

MR. MORRIS: No.

MR. WHITCOMB: If your Honor please, we want to enter an objection, to apply to all this testimony, namely, that it is the claims, under Section 4887, that must be compared, that is, what is patented in a foreign country is that which is covered by the claims.

THE COURT: Well, I guess you better get me the statute.

(Discussion off the record.)

THE COURT: Well, of course, I will take it subject to the objection.

MR. WHITCOMB: Yes.

THE COURT: I will be glad to know just what the issue is in a general way as we go along.

MR. WHITCOMB: Plaintiff's position is that the claims of those patents cover what was patented, and we have other cases in this country we are going to rely on as well.

THE COURT: Just mere disclosure of the specification—

MR. WHITCOMB: —is not sufficient, and the claims give the "out" which make the patents in this country valid.

THE COURT: Well, that is all right, I am very glad to have had that discussion, but it all arose from the question in my mind whether it was necessary to read very much of these patents.

MR. MORRIS: I don't know that it is.

THE COURT: However, you use your judgment about it.

MR. MORRIS: I am wondering how far your Honor cares to have an expert go, because if you would prefer to have counsel do it instead of having an expert do it I don't know that there is any particular thing in any of these patents that counsel cannot deal with by pointing out—

MR. WHITCOMB: We would be willing to go along the same way on that.

THE COURT: Well, it will save some time if it can be done. If it is a mere question of comparison of the language of the patents I don't see why it requires an expert. If it is a question of interpreting some of these terms, I have reached a

point now where I think I know what lead suboxide is.

MR. MORRIS: Well, I am sure I haven't.

THE COURT: Well, at least, I know what the parties contend that it is,—

MR. WHITCOMB: Yes.

THE COURT: —if I may say that, put it that way.

MR. MORRIS: Well, I thought I knew until Dr. Clark testified this morning, and then he gives us such a new picture from anything we had before; but I think in these two, if your Honor please, there is a question of interpretation of lead powder.

THE COURT: Well, there are the words "chemically reactive powder", manufacturing chemically reactive lead powder in the claim. Well, you go ahead.

MR. WHITCOMB: Do you want to inject any law here as we go along? That is the very point in the Third Circuit Court of Appeals case we rely on.

THE COURT: What is the case?

MR. WHITCOMB: Altoona Publix Theatres vs. Tri-Ergon, 72 Federal Second, 53.

MR. MORRIS: Which I happened to be in, and was unfortunately reversed by the Supreme Court of the United States.

MR. WHITCOMB: Not on that point, on validity.

MR. MORRIS: But the case was reversed.



THE COURT: All right.

MR. WHITCOMB: "There are many features disclosed in the German patent which are not claimed, and in law the patent stands as though the features were not disclosed", citing the Supreme Court case, Davis-Bournonville vs. Alexander Milburn.

"All of the above-mentioned elements, not disclosed in the German patent, coact with all the others in the combination. If they were eliminated, the results of the combination could not be obtained. It is evident that we have in this patent a combination and method not disclosed in the German patent."

That is the essence that I read first.

THE COURT: Yes, well, all right, Judge, you will have to use your own judgment about it.

The witness, resuming, testified: Comparing the two exhibits, Defendant's 111 and 112, with the patent in suit, 149, for the purpose of stating what is meant by lead powder in the claims, in my opinion the term "lead powder" used in these three exhibits means a powder derived from or containing lead, not necessarily in the form of metallic lead, but lead in some partially oxidized condition, and I am basing that opinion on the testimony of the experts that have already been heard, to the effect that no product can be obtained from a rotating mill of this kind, under the conditions described, unless the lead is partially oxidized.

I also find an example of the use of the term "lead powder" with this definition in the file wrapper and contents of patent 020, page 38, second paragraph, which reads as follows:

Applicant revolves his tumbling mill, thus causing the lead particles to grind off the lead suboxide formed on the surface. Applicant finds that by keeping the lead suboxide ground off as fast as it is formed and then blowing it out of the mill he can produce this powder in its best form, but, as the Examiner knows, lead powder is poisonous in the air, and to prevent it from impregnating the air surrounding the mill applicant separates the powder from the air by passing the mixture of air and powder through a filter.

The term "lead powder" is referred to in the line where it says lead powder is poisonous in the air; is used as referring to the partially oxidized lead powder

MR. WHITCOMB: If Your Honor please, I object to the use of the file wrapper arguments. As I understand, file wrappers are admissible principally only for showing estoppel, or something like that.

THE COURT: Well, I will note your objection and take it subject to the objection.

I find on line 4 of page 2 of the patent in suit 479, the expression "lead suboxide", and in parentheses PbO. That is page one, line 4 of patent 479. I do not find in either patent 449 in suit or in Exhibits 111 and 112 any limitation upon the amount of oxidation which might take place in either of those three patents.

MR. MORRIS: I offer in evidence Belgian patent number 284,885, dated February 4, 1920, as Defendant's Exhibit 113; the translation thereof as 113-A; I offer in evidence as 113-B the certificate of an official of Belgium showing the date

of publication of the Belgian patent; as 113-C a translation of that; 113-D, a Brevet; 113-E, the translation of the Brevet.

MR. WHITCOMB: Counsel for plaintiff objects to the introduction of all those exhibits without exception, on the ground that in this case the patent was not published, and, therefore, does not serve as a printed publication, as do patents in several countries, like the United States, where it is issued and printed right away.

THE COURT: I know, they have some different system there.

MR. WHITCOMB: Yes.

THE COURT: I remember something about that.

MR. WHITCOMB: So again it will be a question of what is patented, and, therefore, you will have to look at the claims again in those patents.

Belgian patent number 284,885, dated February 4, 1920, was marked Defendant's Exhibit number 113.

Translation of Belgian patent number 284,885, dated February 4, 1920, was marked Defendant's Exhibit number 113-A.

Certificate showing date of publication of Belgian patent 284,885 was marked Defendant's Exhibit number 113-B.

Translation of certificate showing date of publication was marked Defendant's Exhibit number 113-C.

Photostat of Brevet, dated 1920, relating to Belgian patent 284,885, was marked Defendant's Exhibit number 113-D.

Translation of Brevet relating to Belgian patent 284,885, was marked Defendant's Exhibit number 113-E.)

MR. MORRIS: Exhibit 113-C, which you have, is by the Ministry of Industry, Labor and Social Affairs, Brussels, General Headquarters, 2nd section—Industrial Property, 1st office, Administrative Service: "I, the undersigned, Maurice CAPART, Director, Chief Official of Industrial Property, declare that the Belgian patent No. 284885 of February 4, 1920, was made public on May 4, 1920, and that the Miscel any of Patents containing a resume of the patent above mentioned was published February 15, 1922. Brussels, the 16th June, 1934." Director, Chief Official, and signed Capart. On the back of the official document is the attestation of the United States Consul.

MR. WHITCOMB: But that refers to just that Brevet that was published.

MR. MORRIS: Oh, no. Here it is—this is not anything (indicating).

MR. WHITCOMB: You can get a printed copy?

MR. MORRIS: All I have got is just what I have got in my hand.

MR. WHITCOMB: What you gave us was typewritten.

MR. MORRIS: True. We had only one official copy, the original. And did we give you a copy of this (indicating)?

MR. WHITCOMB: No.

MR. MORRIS: Well, there they are (tendering).

MR. WHITCOMB: Of course, we registered our objection to all of that. I think we should further object to this certificate as being a conclusion of some officer and no facts are shown to support that.

THE COURT: All right. The objection is noted.

MR. MORRIS: I offer in evidence, as the Defendant's Exhibit 114, the patent to J. M. G. Fullman of March 14, 1916, patent number 1174-975. As 115, I offer in evidence U. S. patent to J. W. Bailey number 846384 of March 5, 1904.

THE COURT: Will you have a file of this prior art for me? Do you have a file of this prior art?

MR. MORRIS: Yes, sir. I will hand it up.

THE COURT: That's all right. I mean, you should have it all together somewhere.

MR. MORRIS: Yes, sir. I will re-assemble one.

THE COURT: All right. Go ahead.

MR. MORRIS: As Defendant's Exhibit No. 116, I offer patent issued to Thibault number 494270. As 116-A, I offer the translation of the Thibault patent, subject, of course, to correction if it should be corrected. As 117, I offer United States patent number 1441168 and, as 118, the patent to Hardinge, 1450289, filed April 29, 1920, and issued April 3, 1923.

Now, just in passing I want to call your Honor's attention to that; there's the mill, and the air is down here (indicating).

As 119, I offer the British patent number 11602 of 1890—that's 119.

As 120,—

MR. WHITCOMB: What was that last one? We didn't get notice of that.

MR. MORRIS: 11602 of 1890.

MR. WHITCOMB: What's the name?

MR. MORRIS: It is Bischof.

MR. WHITCOMB: Oh.

MR. MORRIS: As Defendant's Exhibit 120, I offer in evidence the Canadian patent to Shimadzu, number 243794, dated the 21st day of October, 1924, it having been applied for February 19, 1923, and issued October 21, 1924, which is more than twelve months before the issue of the prior patent '151—applied for more than twelve months prior thereto.

MR. WHITCOMB: As to this patent we wish to make the further objection that we did not receive thirty days' notice of the offer. That's in addition to the other point. Those patents of which we received no notice more than thirty days prior to the offer are admissible only to show the state of the art, and we make the same objection as we did before about the claims.

THE COURT: All right.

MR. MORRIS: All right. I thought it was more than thirty days but, since it is Shimadzu's own patent, I think that does not apply. But that doesn't matter.

But, here's patent '121, the patent to Shimadzu—the patent to Shimadzu, Japanese number 41953—applied for August 29, 1920, issued March 10, 1922.

MR. WHITCOMB: We enter that same objection about the disclosure versus the claims.

MR. MORRIS: I offer in evidence, as our Exhibit 122, a publication by Doctor Lucas in 1917. We have the book and the translation here.

(Discussion off the record.)

MR. MORRIS: I will let you see the book. You know the book?

MR. WHITCOMB: Yes.

MR. MORRIS: So, we will offer that book, the pertinent page of it, as our Exhibit 122.

As 123, we offer in evidence the British patent number 4809 of 1882 to Tatham.

MR. WHITCOMB: We want to enter the same objection about the notice on that last British patent.

MR. SCHAFFER: We didn't have thirty days' notice.

MR. WHITCOMB: I will have a standing objection on that?

THE COURT: Yes.

MR. MORRIS: As the defendant's Exhibit 122-A, I offer a translation of Doctor Lucas' book of 1917, with respect to the pertinent page. Will your Honor pardon me just a moment?

The witness, resuming, testified: Taking your file, I will compare the exhibits which have just been offered in evidence of the patents and the article by Dr. Lucas with the patents or the process of the patents in suit. The first patent referred to is Exhibit



number 111, the Japanese Patent No. 41728. I have already explained about that. Belgian Patent No. 284885, Exhibit number 113, issued to the Tudor Accumulateurs, which is the Tudor Storage Battery Company, in France, describes a method for producing lead powder by putting balls of lead into a metallic rotating drum perforated with holes, by the rotation of the drum—by the rotation of the drum the balls rub on one another, and there is produced a fine powder of the metal which, passing through the holes in the drum, can be collected on the outside.

The patent or the process further states that, with the help primarily of the heat liberated by the friction of the balls and also as a consequence of the air in the rotating of the drum, the particles of lead powder detached from the balls undergo the beginning of oxidation, and it is possible to control this oxidation by changing the volume of the balls, or by varying the revolutions of the drum or, finally, by making a supplemental entrance of air in the casing. In other words, by controlling the supply of air.

The process can be so controlled as to produce either metallic lead powder or any—or any of the oxides of lead powder. For example, it is said that if it is desired to delay the transformation of the lead powder into oxide, it is sufficient to plug up all of the entrances for air into the apparatus and store up the lead powder in the metallic state. It is possible, subsequently, to transform this lead powder into such or such oxide of lead at the desired moment by submitting it to an action, more or less active, of the oxygen of the air.

I believe that this process, as disclosed in this patent, corresponds exactly with the processes described in the patents in suit,—149 which refers to

lead powder, and '150 which refers to an oxidized powder of lead—and, while the Belgian patent does not specifically refer to lead suboxide, the testimony of the experts that have testified in this case shows that any oxidation of lead must pass through the suboxide stage, if that testimony is correct.

The Belgian patent discloses the control of the supply of air, which is also mentioned in certain of the patents in suit.

I believe that covers the comparison of that patent with the patents in suit.

The next one that was mentioned was Fullman Patent 1,174,975, Exhibit 114. The patent to Fullman discloses a rotating drum, perforated with holes, with an air pipe extending into the interior of the drum having jets from which air, under pressure, may be discharged into the interior of the drum. This apparatus is described as applied for grinding or abrading materials and for blowing the material thus abraded out of the drum by means of the jet of air. On page two, line thirty-eight. It describes the second form in which the jets of air are introduced into the inside of the drum:

In this form the streams of air, instead of being directed from outside into the barrel, are released from within the barrel and play directly upon the articles under treatment.

The treatment is for abrading oxidized particles from the surface of the metal. I think I have no further comment with respect to Fullman.

Comparing it with the patents in suit, 149, 150 and 151, in '149 a similar step in the process is dis-

closed. At the bottom of the first column on page one,

“ . . . within this cylinder is fitted an air blower provided with small holes.”

And in the second column, line sixty-seven,

“ . . . air blast having a pressure of 2.5 pounds per square inch is sent out of the air blower.”

This description corresponds exactly with the disclosure in the Fullman patent.

In patent 1150, on page two, line ten, the statement is made:

“ . . . that any such oxidizing agent may be blown into the cylinder in a gust, or may cause the cylinder to suck it. If it is blown into it, it is convenient to utilize the force of the current thus caused to blow the powder formed out of the cylinder and then collect it.”

That reference indicates that blowing the powder out of the cylinder is a matter of convenience but not a necessary step in the process.

In patent 1151, the same step is disclosed on page one, line thirty—or, line twenty-nine—where it refers to blowing the air into the drum all the while.

I don't find in 1479 a direct reference to a blower, although it does refer to the introduction of air into the drum.

Mr. MORRIS: I inadvertently, in assembling from the mass of the prior art this morning, omitted British Patent number 13202, of 1898.

which refers to the British Patent 11602, of 1890, which I did put in evidence.

MR. WHITCOMB: We want to make the objection that the exhibit 119, the British Patent 11602 of 1890, was never cited in the answer or in the answer to the bill of particulars.

THE COURT: All right, I will note the objection.

MR. MORRIS: But 13202 of 1898 was, and I am now offering as Exhibit 124 number 13202.

MR. KWIS: Of what year?

MR. MORRIS: Of 1898.

(Photostat of British Patent 13,202, of 1898, was marked Defendant's Exhibit number 124.)

MR. MORRIS: And the opinion of the C. C. P. A. in the Interference is reported in 59 Federal Second 225. It always seems strange to me to offer an opinion, but I find in certain cases an opinion should be offered as constituting part of the record.

THE COURT: Is that so? I never heard of it.

MR. MORRIS: It came as a great deal of surprise to me, when I first heard of it myself.

THE COURT: I am sure the stenographer won't object.

MR. MORRIS: No, I don't want it read into the record.

THE COURT: Oh.

MR. MORRIS: I am just offering it without really putting in a copy, because it is always in

the Federal, so I am offering as Exhibit 125 the opinion of the C. C. P. A., in the Hall-Shimadzu Interference cases, which opinion is reported in 59 Federal Second 225, and I ask that it be not even included among the physical exhibits, because it is available in 59 Federal Second.

MR. WHITCOMB: We agree.

The witness, resuming, testified: I think I had finished Fullman.

The next patent is the exhibit, Defendant's Exhibit number 115, issued to John W. Bailey, United States Patent number 846,384, dated March 5, 1907. This patent discloses a process for producing lead powder in a stationary chamber in which are located a number of so-called beaters, these beaters being somewhat like squirrel cage devices, which are revolved at sufficiently high velocity to produce the desired results. Into this chamber is introduced lead in the form of coarse powder, coarse grained powder, and by contact with the revolving beaters it is reduced to a fine, impalpable powder.

This is Bailey, 846,384. There are two Bailey patents. I would say that that is similar to this process because the Bailey process, the preferred embodiment states, at the top of page two: "While this process of producing the new product is preferred, it is possible that the product may be produced in other ways, as by a grinding or abrading process." The raw material is in the form of a coarse grained powder and it is reduced. It seems to me that that language at the top of page two would naturally suggest what was very well known at that time, the ordinary ball mill. At the bottom of the first column of page 1 he states:

"I have discovered that the metallic lead may be reduced to the form of a dust or an impalpable and practically amorphous powder and that when it is subjected to chemical action in this condition it is rapidly and uniformly transformed into the ordinary lead pigments and other compounds, such as white lead, litharge, or red lead."

That in my opinion discloses the product of the patents in suit, especially when you refer to line 11—line 9, on page 2, where it says:

"The new product may be substantially pure metal or it may be a mixture of the metal and an oxide thereof. It has a dark gray color."

and so on, and the reference to the powder being in the form, the product being in the form of an impalpable powder would in my opinion be the equivalent of the fine powder referred to in the patents in suit.

Also, where he says on page 1, line 15, he produces the metal in a form which greatly facilitates its chemical union with other substances, it refers very definitely to high chemical reactivity.

Then at the bottom, on page 2, at the bottom of the second column, he states:

"For the purpose of discharging the pulverized lead from the chamber when it has reached a suitable degree of fineness the casing is provided with a discharge-opening 56, which is preferably arranged at or near the top of the chamber, and said opening is connected by a pipe or passage 57 to the suction port of an exhaust fan or blower 58. The delivery-passage 59 of

the fan 58 may be connected to a suitable collecting-chamber in the ordinary manner. Any other suitable means may be provided for maintaining a current of air through the pulverizing-chamber."

Then on the top, in the first column, page 3:

"It follows from this construction that all of the lead introduced into the pulverizing-chamber will be kept in a state of rapid motion and will be continually coming in contact with oppositely-moving parts or particles, whereby it will be rapidly and efficiently reduced to a powder and will not be delivered from the casing until it has been reduced to a fine state, such that it may be conveyed in opposition to the force of gravity by the current of air produced by the fan. By regulating the speed of the fan, therefore, and the consequent velocity of the current of air the degree of fineness of the metal delivered from the pulverizing-chamber may be nicely controlled. The velocity of the current of air, however, will be made so moderate as not to convey the lead out of the pulverizing-chamber until it has been reduced to an impalpable powder."

We find, therefore, in this description the pulverizing process by abrasion, we find the introduction of a current of air, we find the current of air carrying the powder out of the vessel, we find the current of air controlled to produce the desired results.

In reference to the use of a coarse grained powder as referred to I would refer to Shimadzu's Japanese patent number 60825, and to page 1 of the translation, paragraph two.



MR. WHITCOMB: By the way, Your Honor, counsel for the Plaintiff would like to offer in evidence this particular Japanese patent, and asks the clerk to mark the same—I assume that you were not going to introduce it—61.

(Discussion off the record.)

MR. WHITCOMB: We can agree on the one to use, because it is the one that has been exchanged between counsel before trial.

(Shimadzu Patent number 60825 was marked Plaintiffs' Exhibit number 61.)

The witness, resuming, testified: At that point the Japanese patent states that the process—in the process lumps of metallic lead or a coarse powder may be placed inside the rotating vessel. It would appear, therefore, that the use by Bailey of a coarse powder rather than lumps of lead is quite equivalent to the lumps of lead referred to in some of the patents in suit.

The next patent referred to is Defendant's Exhibit number 116, French Patent number 494,270, to Thibault, filed December 30, 1918, and published September 4, 1919. This patent is substantially identical with the United States patent to the same inventor, but carries a somewhat earlier date. This patent to Thibault discloses a process for producing oxides of lead, including litharge, minium, or red lead, by introducing into a rotating drum pieces of lead and a current of air, and rotating the drum, abrading the pieces of lead, and continuing the oxidizing action of the air until the entire contents of the drum is converted into litharge.

This patent refers to the introduction of a certain amount of water vapor into the current of air,

but at the bottom of the second page of the translation; the last paragraph, the statement is made that the transformation is brought about by the simple current of air, as in the other processes, but the fact of accomplishing this reaction in the presence of water vapor favors greatly the action of the oxidizing agents and makes it possible to shorten the operation. It is quite evident from that that the introduction of water vapor has no effect on the product except to hasten the operation, and the result can be obtained without the introduction of water vapor.

The diagram of the apparatus shows a valve at the exit from the chamber "A", which is used to control the stream of air. The air itself is heated in a coil before it enters the chamber, the coil being shown at "E". It appears, therefore, that we have a controlled stream of air and a revolving drum in which pieces of lead are caused to abrade against each other, and are caused to be oxidized until a final product of litharge is produced.

Now, while it is true that the final product sought in this process is litharge, it is shown that it takes about six hours to convert the entire mass into litharge, and, of course, at some earlier stage there must have been a partial conversion of the material into lead oxide, showing that in the early stage—Litharge is lead oxide, but only part of it was converted in the earlier stages of the operation, since it took six hours to convert it all. So that in the earlier stages we would have a product corresponding to the partially oxidized products of the patents in suit. I think a partially oxidized product is a mixture of lead and monoxide.

The next patent referred to is Defendant's Exhibit number 117, U. S. Patent 1,441,168 to Peter-

issued January 2nd, 1923, filed June 5th, 1922. This discloses a process of producing lead suboxide,  $Pb_2O$ , and the product contains also some oxide of lead,  $PbO$ , as shown on lines 13 and 14. It describes the product in line 21 and following in these terms:

"The suboxide of lead is a dark greyish fine-powder which when heated in air burns with a yellow flame to oxide of lead."

That in my opinion discloses the process of patent 151, which covers a process for converting lead suboxide into litharge by the initial application of heat, the process being continued by the heat of the reaction. This gentleman gets his lead suboxide very easily. In the last sentence on the first column it states:

"If the process is properly carried out the suboxide of lead is predominant in the product."

The next reference is exhibit, Defendant's Exhibit number 118, U. S. Patent 1,450,289, to Hardinge. This shows the Hardinge Mill of the structure similar to that of the Defendant, but in addition it shows the introduction of a blast of air into the mill for carrying out the fine product. The patent itself describes very clearly the classifying action of the Hardinge Mill, whereby the fine part of the product gravitates toward the outlet.

I will take up next British Patent 11,602. Defendant's Exhibit 119; this patent number 11,602, of 1890, to Bischof, describes a process for producing lead suboxide,  $Pb_2O$ . He starts with a higher oxide and reduces. He starts with the higher oxides and blows hydrogen gas on them. It is a disclosure of  $Pb_2O$ .

THE COURT: Is the Canadian Patent the same as one of our patents?

MR. MORRIS: 151.

THE COURT: It is identically the same?

MR. MORRIS: The claims are not in the same language,—

THE COURT: All right.

MR. MORRIS: — but the specification is in almost identical language, and the claims, I think, quite similar, substantially—

The witness, resuming, testified: I would like to add a word in regard to this Bischof Patent, which I omitted to mention, where he says in line 25: "I hydrate and oxidize it by slaking it with water and exposing it to the air, the suboxide being thus converted into a higher oxide, probably monoxide." It seems there that he is disclosing the process of oxidizing this suboxide, either by exposure to air or by treatment with water, as disclosed in the Plaintiffs' Patent number 151.

I understand that it is not necessary for me to compare in detail this Canadian Patent with the corresponding United States Patent. Its language is practically identical. I say that the specification and description in the Canadian patent is almost word for word with the patent 151 in suit. I believe that is true.

The next patent referred to is Japanese Patent 41,953, Defendant's Exhibit number 121. The oath in the United States Patent 151 states that no foreign application for said improvement—applications for said improvements have been filed except Japan, August 29, 1920. This Japanese application resulted

in Japanese Patent 41,953, which is Defendant's Exhibit number 121, and this patent discloses a process for producing litharge by the initial application of heat to fine lead powder produced by mechanical grinding or rubbing together lumps of lead. The U. E. application, which is stated to cover the same invention as the Japanese application, the powder converted into litharge, is stated to be lead suboxide intermingled with metallic lead powder. It is evident, then, from those statements that the fine powder of metallic—of lead—fine lead powder referred in the Japanese application is identical with the lead suboxide referred to in the United States application. Now, if this is true, then the lead powder and the process of making it referred to in Japanese patent 41,728, 42,562, and 42,563 are the same process and product as those set forth in United States patent 150. The United States patent 150 was applied for more than a year later than the Japanese applications and was issued earlier—and was issued later.

In further reference to 41,953 the process described consists in subjecting lead powder to the air, and when exposed to the air it is oxidized by the oxygen of the air and because of the heat of reaction a spontaneous reaction goes on and changes the powder to litharge. That, of course, is the same process as described in 151.

I believe that is all.

There is a reference to Dr. Lucas' book. The German book by Dr. Lucas, which was published in 1917, has on page 24 a reference to the use of lead dust in the manufacture of storage battery plates. I will read the translation of the two paragraphs on this page:

"The production of the active layer takes place either by the process of Faure by pasting into the lead grids litharge or red lead, or a mixture of both, or even white lead, or lead dust"—the German word for which is "Bleistaub"—"produced by abrading or pulverizing lead; or by forming a layer of lead-sulphate or lead peroxide out of the surface of the grids or plates by means of the electric current by the original Plante process.

"The lead oxides or salts are stirred with caustic potash or glycerine or sulphuric acid, or mixtures thereof, to which also perhaps many a resin or alcohol is added, into a stiff paste which either by hand or by machines is pasted into the grids and electrolytically reduced or oxidized."

The rest is not of any important bearing. Now, this discloses the use of the powder which was known at that time in Germany as Bleistaub, and was the product of the German mills produced by abrading or pulverizing lead balls in the presence of air.

MR. WHITCOMB: It seems to me that is objectionable. He is talking about what actually transpired.

MR. MORRIS: He hasn't finished. I assume that he means testified to in this case.

THE WITNESS: That has been testified to by Mr. Smith.

MR. WHITCOMB: Well, it is objectionable as to what transpired in a foreign country, then, too.

MR. MORRIS: I do not understand Dr. Wood-

bridge's testimony to be as to a matter of fact as to what did happen in Germany, but I understand him to be directing his testimony at the moment to the definition of Bleistaub, which has been shown by Mr. Smith to be the product of the German mills abroad and the German mill as used by the defendant in Philadelphia. I think that—

THE WITNESS: That is what I am intending to state.

THE COURT: All right. I will note the objection. Go ahead.

THE WITNESS: And this word "Bleistaub" is the same word that is used by the plaintiff, Shimadzu, in his German patent to describe his product. Therefore, it seems perfectly obvious that this publication discloses the use of that material in the manufacture of paste for storage battery plates.

The next patent, Defendant's Exhibit 123, is British Patent to Tatham, 4809 of 1882.

This patent discloses the use of lead suboxide in the paste of storage battery plates. He refers to mixing the powder with paper pulp, and is described more particularly in lines 39 and following of the complete specification, which reads as follows:

"Paper pulp prepared from unsized paper, cotton, linen rags or other vegetable fibre is mixed when moist with twelve times its volume of peroxide of lead for the positive element or anode and with a similar quantity by volume of suboxide of lead for the negative element or



cathode so that the mixture or compound contains about 93 per cent. by volume of the metallic or active agent."

That, I believe, discloses the use of suboxide of lead in the paste of storage battery plates.

Was that the last reference patent?

I will now take up British Patent to Bischof, 13,202 of 1898, which is Defendant's Exhibit 124. This patent discloses apparatus for the production of  $Pb_2O$ , and refers to the process disclosed in specification 11,602 of 1890. The process itself for producing the suboxide consists in reducing the higher oxides to suboxide, but I believe I have explained that in connection with 11,602.

I don't find that reference to the conversion of suboxide into  $PbO$  by heat, by the heat of reaction, which is given in the other patent. There is a reference to cooling the product  $Pb_2O$  as it descends through the passage, which would, of course, indicate that it is necessary to do this in order to prevent its further oxidation.

Now, Dr. Woodbridge, will you be good enough to turn to the abandoned application of Shimadzu, number 431,473, filed December 11, 1920, and compare and point out its similarities, if any, and differences, if any, to the disclosures of patents 150, 151, 152, in suit?

A. 152 isn't in, is it?

Q I don't know whether 152 is in suit or not.

MR. MORRIS: I wonder if we can inquire, is 152 in suit here?

MR. SCHAEFFER: We have given notice that we are not relying on any of the claims.

MR. KWIS: You have given notice.

MR. MORRIS: I didn't know.

MR. SCHAFFER: Yes.

MR. STOUGHTON: 152 is out.

MR. MORRIS: 152 is out; I didn't know that.

(The witness resuming testified):

This abandoned application describes a process for converting finely divided lead powder into the higher oxides. It does not refer in any way to the method of producing the fine lead powder. It does not refer to a rotating drum. It does say, "I pulverize metallic lead by mechanical means into fine powder". That, I believe, is the only reference to any process of producing the fine powder, and it then discloses the subject of igniting this powder and continuing the reaction by the heat of reaction until the entire mass is converted into litharge.

I do not find any reference to suboxide, any reference to putting balls of lead into a revolving drum, I do not find any references to introducing a current of air or controlling any such current of air, or controlling the temperature for the production of this powder, and apparently the only step in the process disclosed is the further oxidation of finely divided lead powder by the initial ignition of the powder and continuing the reaction by the heat of reaction.

It does state at the bottom of page three:

"It is also necessary that fresh lead powder be employed, as suboxidized lead is less active than pure lead."

I believe that is the only place where the word

"suboxidized lead" is mentioned, and it appears to be excluded from the process described.

*Cross-examination.*

By MR. WHITCOMB:

I think I have not found that term "suboxide" in any patents where I haven't mentioned it.

Q. And that applies to the Japanese patent 41,728, the Japanese patent 42,563, your exhibits 111 and 112. The Fullman patent, your Exhibit 114, does not mention lead at all, does it?

A. No.

The Bailey patent, our Exhibit 115, does not mention suboxide. The French patent to Thibault does not mention suboxide. I don't recall very distinctly the prosecution of the Hall application by Mr. Stoughton; I may have had some information. I don't think our company owned the Hall application. I believe we were operating under the Hall patent. Mr. Hall is an employee of the company and Mr. Stoughton prosecuted the patent application in interference and I believe represents both parties. I am not very familiar with the statement of Mr. Stoughton's with respect to the Thibault patent in the file wrapper, Plaintiffs' Exhibit 18, of the Hall patent, 1,888,823, where he says: "therefore these claims"—and he is referring to the claims of the Interference, some of the claims now involved in this suit—"differentiate from Thibault who has two oxidizing gases, air and steam. The steam acts as a catalyst in the presence of applied heat producing lead hydrate which in the presence of heat and air goes to litharge. With superheated steam and air and without applied heat the reaction would not start until the mill got full of water and then it would be

a wet process. It apparently not only requires applied heat but also pressure to get a reaction with air and superheated steam. The real limitation in the claims under discussion is that a single oxidizing gas, air, produces an entirely different result from the two oxidizing gases of Thibault." I would like to read it over rather carefully before expressing an opinion. (The file wrapper was shown to the witness.)

I do not entirely agree with this opinion of Mr. Stoughton's. In the first place, it appears to be limited to the preferred process of Thibault, in which he introduces steam, and does not refer to Thibault's alternative, in which steam is omitted. There is a question in my mind whether the reaction would not start with superheated steam and air and without applied heat, but I don't know that that has any bearing on the case. You could hardly get superheated steam and air without a rise of temperature.

Referring to the Belgian Tudor patent, Exhibit 113, I believe that no temperature limits are given there. I believe there is no forced draft mentioned there, no fan illustrated or described. Moreover, he says that he can operate with or without air. I would take that to mean that he can get any range of oxidation that he wants, and even down to metallic powder, as he claims, by controlling the amount of air down to the point of excluding air. I think he probably was mistaken in supposing that he could get a product without any air at all. I don't think he could get the metallic powder without air. Metal powder can be broader than a powder composed exclusively and solely of metallic lead. In line three of the second paragraph he says he is producing a powder of the metal—"Fine powder of the metal".

I think he probably means the same thing that is implied in the '149 patent of Shimadzu and in the Japanese patent corresponding. This is the Tudor Belgian Brevet. This was translated by Professor Hopkins in Lafayette College.

Turning to page 2 of the translation of the Belgian main patent, it is stated: "It will then be possible to transform this lead powder, whenever desired into one or the other oxide of lead, by submitting it to a greater or less activity of the oxygen and the air."

I think that it is quite clear as to just what this language taken in connection with the entire description actually means. He can by restricting the air produce, as he claims, a metallic lead powder, he evidently thought that he could, and that if he does produce that lead powder he can store it up and later convert it into any of the lead oxides, but if he does not exclude the air from his mill he can produce directly in the mill any oxide that he wants. That is, take this statement, about the second paragraph above the one to which you referred: "thus by these methods of reaction the whole range of lead oxides will be obtained." That is, it comes before he refers to getting a pure lead powder, and then transforming it into a higher oxide.

Q. But, in any event, when he describes the admission of air he talks about its admission and control of its admission to the casing and not into the drum where the balls are, isn't that correct?

A. I don't see the place that you refer to, where you speak of stopping the entrance of air into the casing.

Q. The word "casing" appears—

A. Yes.

Q. — in the last line—

A. Yes.

Q. — of the middle paragraph on the first page.

A. That indicates that he can provide an additional supply of air to that which was provided for in the earlier part of the description, by making a supplementary entrance of air into the casing.

Q. Well, is there any reference to any air getting into the drum except that that was present with the drum when it was started, so that the powder can get this very initial oxidation that you referred to on your direct testimony?

A. He refers to the air present in the rotating drum. That does not necessarily limit it to the air that is there initially.—

Q. But when he refers—

A. — without any further admission.

Q. — to any additional air, he merely says that he will supply it to the casing, isn't that correct? If not, point out where he says he supplies it anywhere else.

This supplementary entrance of air is supplied to the casing, but, of course, it enters the drum through the holes that are described, which perforate the drum all the way around.

There is no stack mentioned. There is no drawing. There could, course, be no supplementary entrance of air in the casing unless there were some way for it to escape, it would finally create an enormous pressure. — I heard Mr. Smith testify that in practice without the stack the air leaked out through the cracks and so forth. I don't disagree with him. I am just agreeing with him. I am not pointing out that there would have to be a stack. I am pointing out that there would have to be some exit for the air that is provided by this supplementary entrance,

to get out of the whole apparatus. That is not pointed out anywhere in the patent. There is no mention of that. I don't find any reference in this Belgian patent, direct reference to temperature, nor to speed of rotation.

Q. Moreover, doesn't he say toward the end of the patent, third paragraph from the end, I believe, counting that little paragraph, that it is obvious that the same results could be secured by using mechanical means, for example, a shaking table, is that right?

A. What paragraph—yes, in the paragraph at the top of the last page.

Q. Yes.

A. Or haven't you the same?

Q. Yes.

A. Yes, he refers to a shaking table.

Q. You referred to the U. S. Peters patent, 1,441,668, and I didn't understand whether you claim that suboxide could have been made or could not have been made at the date of that patent. What is your position?

A. My personal opinion is that there is no such thing as suboxide of lead.

Q. Then how could you say that that patent discloses suboxide of lead and anticipates any of the patents in suit.

A. Well, of course, if my personal opinion is going to rule, then there wouldn't be any suboxide of lead in the patents in suit.

Hall has been in the room witnessing the proceeding a good deal of the time I believe ever since we have been here and defendant opened its case. I knew Hall was trying to get an application for patent and had these interference proceedings. At that time I was very doubtful of there being suboxide of lead as a definite chemical compound.



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*Ré-direct-examination.*

By MR. MORRIS:

I was of opinion that Hall had made at times such a product as was described according to its physical properties in the Shimadzu patent.

Q. Are you now speaking of the gray oxide, which is the product of Defendant's mills, or of some of the other products made by Hall's mill?

A. I am speaking of some of the other products made by Hall's mill which had those characteristics. Hall had made oxides of lead which were chemically reactive. So much so that they were spontaneously converted into litharge by a mere exposing to air. I am referring to other oxides that he made and not to his gray oxide. The kind of oxide that would be converted into litharge on exposure to air would be a powder that contained much less proportion of oxide than the gray oxide contains, and much more of the highly reactive lead powder. At that time there was very considerable disagreement on the part of authorities as to what that dark powder actually was.

Many thought it was suboxide, and others thought that it was metallic lead and litharge, and later investigations have shown that it is metallic lead and litharge, and does not contain suboxide, and that the highly reactive characteristic is due to the large proportion of the metallic lead. Turning now to the abandoned application of Shimadzu, it states: "It is also necessary that fresh lead powder be employed, as suboxidized lead is less active than pure lead". At the bottom of the first column of patent '150, the sentence beginning at line 54 and continuing through two or three lines reads: "It is a porous mass of amorphous particles and although not very much different in its property from metallic lead, it is so

chemically reactive that it is spontaneously converted into litharge by merely exposing it to air. If a drop of water is dropped—"

MR. MORRIS: No, that is far enough. The point of that, if I can make it clear, so that our case will appear, is this, that is, the metallic lead, unoxidized metallic lead, is pyrophoric, and will take fire if you toss it in the air, because it has affinity for lead, which has not been satisfied.

THE COURT: For air, for oxygen.

MR. MORRIS: For oxygen, thank you: provided the particles are small enough. To my mind I compare it with the shavings of a white pine board, put a match to them and they will go like that (indicating), but you can hold a match to the board for a long time and get no result.

Now, the more, let's call it  $PbO$ , that we have in a mixture, and the distribution of the lead and the  $PbO$  is one way, suppose the lead is on the outside, with the  $PbO$  as a core, then you have a mixture of metallic lead and  $PbO$ , where the metallic lead is the thing that is exposed to the air, and consequently it is highly reactive. Now, the more  $PbO$  you have in that mixture the less reactive it becomes, assuming the physical distribution of the two elements is the same, and we do not disagree with the plaintiff on that, because he says in his abandoned application that it is highly reactive metallic lead, and then he says his  $Pb_2O$  is not much different, but slightly less reactive, and the thought about the Hall application, as is shown without reading it as a whole, by the Interference record, is that the

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matter that was there involved was not gray oxide at all, which is here involved, but was these lower oxides that meet the requirements of 150, and if that was  $Pb_2O$  for Shimadzu, it was  $Pb_2O$  for any other man who had made that same product.

THE COURT: Yes, I understand that, but, you see, the point as I really stopped the plaintiff from examining about the Hall application, or from cross-examining, I mean, about the Hall application. The only thing that got in the case was, namely, the question whether at a certain period of time, namely, the time when Hall made his application, Dr. Woodbridge was of the same opinion as he is now as to the existence of  $Pb_2O$ , and he says at that time he was doubtful. Now, that is really all there is in this testimony to examine about. I don't think there is any occasion now for going into the Hall application. There may be later on.

By THE COURT:

Q. Did you want to say something?

A. I just wanted to add one word in regard to my present opinion.

Q. Yes.

A. That is, my present opinion in regard to the non-existence of suboxide of lead has been very much strengthened after hearing the evidence in this case, than it was at the time of the Hall—

By MR. MORRIS:

Q. And by conferences with certain of the other witnesses that are to be called?

A. Yes.

Witness excused.

WHEELER P. DAVEY, was called as an expert witness on behalf of defendant and having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

My residence is State College, Pennsylvania. My occupation is Research Professor of Physics and Chemistry. I have had graduate training in physics with a Master's Degree at Pennsylvania State College; Ph. D. in physics at Cornell University; thirteen years as research physicist and what turned out to be physicist-chemist, but it wasn't known as that in those days, for the Research Laboratory of the General Electric Company. I was with the General Electric as research physicist for about thirteen years. I first started working with X-rays in the fall of 1909.

Q. Are you able to tell me, Dr. Davey, whether materials can be identified by X-ray diffraction methods and, if so, will you tell me how?

A. The X-ray diffraction pattern of a pure crystalline substance is definitely characteristic of that material. The ability to produce that characteristic diffraction pattern is just as much a fundamental property of a pure crystalline substance as is its density, its boiling point, or its melting point, and it is just as useful as a means of identification.

In speaking of a definite characteristic diffraction pattern in this way, I wish to be understood as referring not only to the relative intensities of the various lines in the pattern but also to the definite value of the interplanar spacings—

MR. WHITCOMB: Our colleague, Dr. Clark,

wants to call attention to the fact that the witness is just reading.

By MR. MORRIS:

Q. What is it you are reading from, Dr. Davey?

A. My own handwriting, notes in my own handwriting.

Q. And you are using the notes for what purpose?

A. For the sake of making the record accurate, as accurate as possible.

Q. And as long as possible?

A. No, as short as possible.

THE COURT: All right. It's all right. I have no objection.

THE WITNESS: I can do it without the notes, if the Court pleases, but it will take longer and the transcript record may not be quite as clear.

THE COURT: It doesn't matter to me.

By MR. MORRIS:

Q. I haven't seen those notes, have I?

A. You have never seen those notes. I wrote them out for my own convenience.

Q. Very well. Proceed.

A. If a crystal analyst is asked to identify a specimen of a pure crystalline material, he first—

THE COURT: The only thing is when you read it—all right, go ahead.

THE WITNESS: If a crystal analyst is asked to identify a specimen of a pure crystalline material, he first determines the type of diffraction pattern from this material and then compares

this pattern with patterns of the same type made from standard materials which have been previously chemically identified. When he finds a standard diffraction pattern which exactly matches the pattern of his specimen, he has identified that specimen.

• The crystal analyst is, in his work, in much the same position as a fingerprint expert. When a fingerprint expert is handed a fingerprint and is asked who the person is who made it, he must first determine the type of fingerprint and then search through his files and the files of others in order to find the fingerprint of some known person whose prints will exactly match those which have been submitted to him. If he can find a set of standard fingerprints which exactly match those submitted to him, he has positively identified the person who made the prints. If no exact match can be found, the only way the fingerprint expert can identify his man is to take, systematically, the fingerprints of every one in the world who has not yet been fingerprinted until he finally stumbles upon the correct man.

Similarly, if the crystal analyst can find no exact match he must, in order to identify his unknown specimen by means of its X-ray diffraction pattern, take, systematically, diffraction patterns of known pure, crystalline materials until he finally happens upon the substance which gives an exact match. Then, and not until then, has he identified the unknown specimen.

In the case of the so-called  $PbO$ , there is no standard diffraction pattern on record. Two attempts have been made to establish such a



standard pattern—one published by Ferrari and one given in this Court by Dr. Clark. Ferrari made some material of some sort in accordance with a recipe which was reputed to give  $Pb_2O_3$ . The recipe is in considerable disrepute in many quarters, but Ferrari apparently had an implicit faith in the recipe for he has made no record of an adequate chemical analysis for establishing the identity of his product.

It is my understanding that Ferrari was never able to make but one batch of this product and, from this single batch, he was able to take only a single diffraction pattern of the type which he reported as due to the so-called  $Pb_2O$ . He records that his so-called  $Pb_2O$  must have been unstable for he could not duplicate his original diffraction pattern. So, Ferrari's diffraction pattern, evidently, deals with a substance which he has not been able to duplicate and which he never really identified chemically.

On this ground alone, it cannot be set up as a comparison standard. In addition, the internal evidence of his X-ray diffraction data, as published, indicated a precision of measurement far too low for a comparison standard if that standard is assumed to have a cuprite structure as Dr. Clark has stated it has—

THE COURT: Wait a minute. I am losing track of that. You will have to read that over again.

THE WITNESS: Am I going too fast?

THE COURT: I am going too slow, I guess.

MR. MORRIS: I wish you would go a little slower for us.

THE COURT: It's all right for me, but I want you to read that last again.

THE WITNESS: In addition, the internal evidence of his X-ray diffraction data, as published, indicated a precision of measurement far too low for a comparison standard—

By THE COURT:

Q. You mean it was too slovenly a measurement?

A. Possibly not too slovenly. It may have been that he had a very messy diffraction pattern and couldn't measure it very accurately.

Q. What do you mean by a too low precision?

A. I mean that the evidence—

Q. You mean it was not precise?

A. This difficulty: Measurements of the interplanar spacings—

Q. Those are the lines?

A. Yes. He couldn't locate his lines accurately enough, if we assume that this standard is to have a cuprite structure. I will show evidence later—

Q. If you assume—

A. If you assume that Ferrari had, as he claimed he had, a cuprite structure, the match—

Q. Then his lines were not accurately enough located?

A. His lines were not accurately located. The match between the lines he recorded and the pattern which he should have had, for a face-centered cubic type is very poor. Does that make the statement plain?

Q. Maybe I am just—well, I don't see—if he didn't have enough precision for one purpose, I would think he wouldn't have enough precision for any purpose. You say he didn't have enough pre-

cision if you assume he had a cuprite structure. I don't see why it was conditional at all there.

A. Yes. On Ferrari's photographic film, he had two diffraction patterns—

Q. Yes.

A. —and one was metallic lead, the other was this so-called  $Pb_2O$ . The diffraction pattern for metallic lead is pretty well known, and the match which you could get between that true lead pattern and the pattern which Ferrari got for his lead wasn't too good. Ferrari also claimed that his  $Pb_2O$ , so-called, had a cuprite structure. He made the same claim for it that Dr. Clark made in his original testimony.

Now, if that  $Pb_2O$  had a cuprite structure, there must be certain definite, mathematical relationships between the lines in his pattern. Those lines in Ferrari's pattern do not match those mathematical relationships, except if you are willing to grant the rather coarse approximations in his measurements.

Q. All right.

A. Does that make it plain?

Q. Yes. I think you had better go ahead. I don't want to get you off the track.

A. Don't you worry about that.

By Mr. MORRIS:

Q. Suppose you proceed, and then we will come back to the cuprite structure later.

A. Clark also made some material of some sort using the same general recipe followed by Ferrari—

Q. A little slower please, Mr. Davey.

A. Clark also made some material of this sort, using the same recipe that was followed by Ferrari.

By THE COURT:

Q. That was his oxalate?

A. Oxalate— $\text{Pb}_2\text{O}$ .

Q. That was the recipe that Ferrari used?

A. Yes.

THE COURT: All right.

THE WITNESS: Clark has admitted to this Court that he had no qualitative test for so-called  $\text{Pb}_2\text{O}$ , and that his quantitative analysis was not capable of distinguishing between his so-called  $\text{Pb}_2\text{O}$  and the well-known  $\text{PbO}$  for the sample he had at his disposal.

Now, as Dr. Clark is a professor in the Chemistry Department of the University of Illinois, and a reputable chemist, and in charge of the courses in analysis, analytical chemistry, there, I assume that his statement is quite sufficient in this regard, so that we can assume that he had a chemically unidentified specimen.

By THE COURT:

Q. Now, is that in his oxalate experiment?

A. Oxalate oxide—for that he had no chemical analysis.

Q. Yes. But that was only one possible experiment? That was only one of his experiments, wasn't it; that was a sort of confirmatory experiment. I understood it. He took a planned oxide—Oxide oxide—wasn't that chemically identified?

A. No.

Q. All right. Your statement is he never made any experiment on a chemically identified substance?

A. Correct. The closest he came to it was in the case of this super-centrifuge sample, where he tested

for lead, out of a total of one-tenth of a gram—that's a thirtieth of an ounce—and he has testified, if I remember correctly, that that analysis was not complete enough to enable him to distinguish between  $Pb_2O$  and  $PbO$ .

By MR. MORRIS:

Q. You said one-thirtieth of an ounce. Wasn't it one-tenth of a gram, and wouldn't that be one-three-hundredth?

A. Excuse me. Yes, that would be one-three-hundredth.

Q. A little more, wouldn't it?

A. About two eighty. Yes, about two eighty.

Q. Yes.

A. He has tried to overcome this defect by trying to show, in his original direct testimony, that his data are at least consistent with the guess that his material was really  $Pb_2O$  and that it had a true cuprite structure.

Such a method of overcoming the lack of a knowledge of the chemical identity of his standard substance involves the error in logic illustrated by the following syllogism: This horse is a quadruped; therefore all quadrupeds are horses.

By THE COURT:

Q. What do you mean by standard substance, the—

A. The thing which would correspond to the fingerprint in the fingerprint expert's files.

MR. WHITCOMB: Your Honor, is this harangue against Dr. Clark or his testimony in this case?

MR. MORRIS: Not against Dr. Clark at all; just against his testimony.

THE COURT: Yes. It is certainly designed to show that Dr. Clark's testimony is of no value whatever to this Court.

THE WITNESS: Dr. Clark and I have been friends—

THE COURT: Yes.

THE WITNESS: — for a great many years. I have known him ever since he was a graduate student.

MR. MORRIS: Will you proceed to deal with his testimony, then, Dr. Davey?

THE COURT: All right, go ahead.

By MR. MORRIS:

Q. May I see if I understood you at one place there, about the chemical analyses testified to by Dr. Clark? Were you dealing with his Berzelius product there or not? Just what was the boundary of what you understood that Dr. Clark had no chemical analysis for?— I just mean, your testimony.

THE COURT: He very broadly said he didn't have any chemical analysis for anything he put the X-ray test to, is that right?

THE WITNESS: He had no chemical analysis for the composition of his so-called  $Pb_2O$  in any of his experiments.

THE COURT: No, no. No, as I understood you to say, he had no chemical analysis of the thing he started with in any case. If I misunderstood you, correct me.

THE WITNESS: Let me make that plain, Judge. If you have a physical mixture of several

materials, all ground up together, an over-all chemical analysis of that ground-up mixture doesn't tell what the individual components would be.

THE COURT: Let me ask you about that—that's one thing I have been missing right along. I don't want to take too long about this, but suppose you have a mixture, a conceded mixture of pure lead and lead oxide.

THE WITNESS: Yes.

THE COURT: Now, I bring you that mixture in a tube, and I ask you what this is—

THE WITNESS: Yes.

THE COURT: — and you don't know anything about it, and you start in and you find there is lead in it and you find there's oxygen in it. Now, in the first place, how much can you tell me about that mixture? Can you tell me that it is lead—by analysis, can you tell me that it is composed of lead and lead oxide, without any question of proportions? Now, suppose that's all there is in it.

THE WITNESS: If the lead oxide happens to be there, red  $Pb_2O$  or yellow—

THE COURT: Yes.

THE WITNESS: —or some other oxide, for which a diffraction pattern—

THE COURT: No, no, I am talking about the chemical analysis.

THE WITNESS: For a chemical analysis, it would be necessary to assume which of the oxides



you had present before you could tell the proportions.

THE COURT: In other words, you couldn't take a mixture of  $PbO$  and  $Pb_2O$  and identify it as that?

THE WITNESS: Except in case there were definite qualitative tests for  $PbO$ , in which you could tell you had  $PbO$  present to the exclusion of other oxides.

THE COURT: Still,—I am giving you a free rein—all I want to know is can you tell me that that mixture is composed of  $PbO$  and  $Pb_2O$ ? Are you able to positively tell me that?

THE WITNESS: If I can find a definite, qualitative test for  $PbO$ —

THE COURT: Well, can you?

THE WITNESS: I don't know.

MR. MORRIS: I think the question your Honor has presented is the chemical end which we are going to deal with with Dr. Ullman.

THE COURT: All right. I've got the wrong man for that.

By MR. MORRIS:

Q. Dr. Davey, your testimony—

MR. MORRIS: Dr. Davey's testimony is merely directed to trying to say or trying to show that some chemical compound has never been identified; the same as his fingerprint expert; but he doesn't tell us how the chemist is going to tell us how to analyze to determine what is in it. Dr. Ullman will tell us that.

THE COURT: All right.

(Discussion off the record.)

By THE COURT:

Q. Well, we were just going back for a minute on Dr. Clark's proposition and, as I understood you to say, none of his substances that he started with or started to analyze were chemically identified?

A. Correct.

THE COURT: All right. Now, go ahead. That's where we get every time.

MR. MORRIS: I thought he straightened that out a moment ago.

THE COURT: I don't think he did.

MR. MORRIS: May I see what he does mean?

THE COURT: Yes.

By MR. MORRIS:

Q. Dr. Davey, do you mean to say that there is nothing, as you understand it, that Dr. Clark gave no testimony at any time about the chemical analysis, about Berzelius' products or anything else?

A. It is my understanding that Dr. Clark testified that he couldn't tell, in his most highly purified product which he claimed was  $PbO$ , that he couldn't tell from that product whether it was  $PbO$  or  $Pb_2O_3$ , that his chemical analysis couldn't distinguish it because such a—

THE COURT: Now, just a minute.

By THE COURT:

Q. Dr. Clark said, by his X-ray analysis or, rather, he subjected it to five or six things, and they

have been brought in. I don't know how many, but there were at least six exhibits—diffraction patterns—and one was powder from Exide, from the Exide plant, and one was the oxalate product—it was the same as Berzelius' or Ferrari's—another was  $\text{Ag}_2\text{O}$  and another  $\text{Cu}_2\text{O}$ .

A. Yes.

Q. I think there were two samples of the Exide product. Now, do I understand that your testimony is or, rather, that your recollection of his testimony is that in none of those did he have any chemical analysis of what he started with? Really, if he had no idea of what he was analyzing when he started in, I don't see why he went ahead with it.

A. Well, I wondered myself.

Q. Yes.

A. Let me explain, Judge, in this way: He brought along a record of a diffraction pattern—

THE COURT: Get me that Exhibit 21, if it is available. I don't want to mix things up here, but that's what happens when a judge tries to follow a thing.

(Discussion off the record.)

By THE COURT:

Q. Now, here's a whole lot of those things—

A. Yes.

Q. — termed lead oxide, dust lead, Japanese oxide, and the fractionated product of the Exide mill, and the original Exide, and oxalate, and one thing and another. Tell me,—

A. Now,—

Q. — keep your mind on that: it is Exhibit 21—tell me what you think he knew about the things he started to analyze.

A. Now, he took the diffraction pattern of metallic lead—

Q. Did he know what that was?

A. He knew that it was metallic lead, because the diffraction entity of chemically identified metallic lead is a matter of scientific record. For metallic lead, then, he is in the position of the fingerprint expert who has the record of this man's fingerprints. Any time he finds that—the diffraction pattern—he can tie it up with metallic lead.

Q. Yes.

A. Now, going down through the Exide oxide, and the Berzelius oxide, and all the rest of them, when he finds this particular diffraction pattern, he is perfectly justified in saying that metallic lead is present.

Q. Surely. I understand that.

A. In the same way, he had a diffraction pattern of, I think, of red and yellow  $\text{PbO}$ , did he not?

Q. I don't remember.

A. That's my memory.

MR. WHITCOMB: Yes.

By THE COURT:

Q. All right. He says yes.

A. Both of those are matters of scientific record.

Q. Yes, he must have had that.

A. Any time that he finds a diffraction pattern corresponding to red  $\text{PbO}$ , he is perfectly justified in saying the oxide contains  $\text{PbO}$ .

Q. All right.

A. He has, also, a diffraction pattern somewhere—I don't remember whether it's on that sheet or not—of something or the other chemically unidentified, which he got from his oxalate experiment. He

has a diffraction pattern of an unknown material. If you can find that diffraction pattern in the Exide oxide, all he has shown is that, that some unknown material is in Exide oxide, but he still hasn't been able to identify it because it is not a chemically identified material in his standard of comparison.

Q. Yes.

A. He's in the same position as a fingerprint expert, who went out on the street and got a set of fingerprints at random and found that they matched the fingerprints he was looking for but he didn't know who he was taking the fingerprint record from. Do you see what I mean?

Q. I see exactly what you mean. I see exactly what you mean, yes.

A. So if he had, as I said—if he had no chemical analysis of the material, giving the—I don't mean the over-all material but of this unknown thing which he calls  $PbO$ .

By MR. MORRIS:

Q.  $PbO$ ?

A. No,  $Pb_2O$ . Yes, if he had no chemical confirmation of the identity of this so-called  $Pb_2O$ , his diffraction pattern is not to be regarded as the diffraction pattern of  $Pb_2O$  but is still to be regarded as the diffraction pattern of an unknown material.

Q. Yes.

A. So,—

By THE COURT:

Q. Go ahead.

A. — he can show the presence of that unknown material in as many products as he wishes, but it is still an unknown material. Now, he has tried to

overcome that defect in his reasoning by saying, as he has testified in his original testimony, that it is plausible to assume the existence of a  $Pb_2O$  and that it is plausible to assume a cuprite structure for it.

Q. Well, I still think it would be rather important for him to know what he started with because, if he started with nothing but lead or lead oxide, then your range of unknown substances is limited, isn't it? If you start with a substance absolutely identified as lead oxide and nothing else chemically, your unknown substance must be an oxide of lead. It couldn't be an oxide of copper, could it?

A. No.

Q. Or an oxide of silver?

A. No.

Q. It would have to be an oxide of lead, wouldn't it?

A. Yes. But it may have been some oxide other than  $Pb_2O$ .

Q. That's right. I agree. Now, then, that gets you back to your proposition that we are talking about, that we were talking about first; that you say he did not know at first that what he started with was lead oxide and nothing else. That's why I am going after that because, it seems to me, that's rather important. If you know the thing you start with is nothing but those two things, you can't get any other elements in it, can you?

A. Yes. You have at least two oxides of lead before you; at least, two.

Q. Yes, I would agree with that.

A. If you have an unknown oxide of lead—

Q. All right.

A. — mixed with lead in unknown proportions, how can you tell how much lead is tied up with the,

up with the oxygen, and how much with the lead itself?

Q. I haven't gotten that far yet. Can you be sure that the unknown substance is some oxide of lead? You call it an unknown substance and, when you say that, it might be—if you know what you started with, doesn't it have to be some oxide of lead?

A. Well, his material had been mixed up with a lot of oil—

Q. I am still trying to get back to your statement that he didn't know what the material was when he started.

MR. MORRIS: May I ask one or two questions?

THE COURT: Just a minute.

By THE COURT:

Q. That leaves you a field of ten million substances, whereas if he knew—

A. If it was lead and another lead compound, it still leaves the field wide open.

By MR. MORRIS:

Q. Could anybody tell what this unknown ingredient was in the mixture that was handed to him until they had first found out what it was?

A. I don't think they could.

Q. He couldn't know what he had was a mixture of lead and lead oxides alone, could he, in toto?

A. No. We are doing him the favor of assuming, for the benefit of the discussion, that this thing he had was a lead oxide.

THE COURT: I am afraid we are getting our



record pretty elaborate, and I wonder if we could talk off the record a few minutes?

MR. WHITCOMB: Why don't you ask Dr. Clark?

THE COURT: Just leave this off the record.

(Discussion off the record.)

THE COURT: Let me ask Dr. Davey a question?

MR. MORRIS: Yes.

THE COURT: Never mind. All right, I will pick it up as we go along. Suppose you go ahead. I have an idea of what you are talking about.

THE WITNESS: What I am trying to—

MR. MORRIS: This becomes part of the record?

THE COURT: Yes.

THE WITNESS: — illustrate, Judge, is that just like a fingerprint man has to have an identified human being to go with the fingerprint, and before some other fingerprint exactly like it means it belongs to this particular man, in this way we must have a chemically identified material to go with this diffraction pattern before Professor Clark can say this diffraction pattern which he found belongs to that particular chemical—and that he has not done.

He says he cannot make the chemical analysis accurately enough—and he is trying to get around that defect in his reasoning by trying

to show how plausible it is to him that if he had a  $\text{Pb}_2\text{O}$  that it would give or would have a cuprite type structure and would, therefore, give a free-centered cubic diffraction pattern.

Now, doing that, he is falling into a syllogical error, the same error illustrated by the old syllogism in college in logic class: This horse is a quadruped, and all quadrupeds, therefore, are horses.

Even though a hypothetical  $\text{Pb}_2\text{O}$  with a cuprite type of structure would show a face-centered cubic type of diffraction pattern, it does not follow that all diffraction patterns of the face-centered cubic type result because of a cuprite type of structure. In fact, Dr. Clark has testified that at least four types of crystal structures would, under conditions like we have in compounds like the oxides of lead, yield diffraction patterns of the face-centered cubic type. So that, even if there had been found a free-centered cubic type of diffraction pattern from the plaintiff's super-centrifugal material, we are still without a standard diffraction pattern of the so-called  $\text{Pb}_2\text{O}$ .

It has, therefore, not been shown by X-ray methods that there is or ever has been any  $\text{Pb}_2\text{O}$ , if such material exists at all, in the Exide oxide. He is still trying to make all quadrupeds into horses, or so we must assume. We must assume, I think, that his attempt to justify his assumption of a cuprite structure for  $\text{Pb}_2\text{O}$  with a lattice parameter—it is still a case of reasoning in a circle. He is assuming a thing which he tries to prove and so, in answer to your question Judge Morris, in order to identify a material which is handed to a crystal analyst, he must be

able to produce a diffraction pattern from that material which is exactly like the diffraction pattern from some which has already been taken from some chemically identified material.

By MR. MORRIS:

Q. Well, now, will you have that read to you? I mean, that last sentence?

(The sentence was then repeated by the reporter, as follows: ✓

"... He is assuming a thing which he tries to prove and so, in answer to your question, Judge Morris, in order to identify a material which is handed to a crystal analyst, he must be able to produce a diffraction pattern from that material which is exactly like the diffraction pattern from some which has already been taken from some chemically identified materials.")

(Discussion off the record.)

THE WITNESS: Is my answer plain enough to be unambiguous?

THE COURT: Yes. Go ahead.

By MR. MORRIS:

Q. Who is to do the identifying of the material in the case that you speak of in your last statement?

A. I'm not sure whether you refer to the standard material or the material submitted for identification.

Q. I take to you, a crystallographer, a test tube full of a certain material—

THE COURT: Do you tell him what it is, first?

MR. MORRIS: I don't tell him a word about it.

By MR. MORRIS:

Q. — and I ask you to tell me what it is,—

A. Yes.

Q. — can you tell me, or not?

A. I can in case it is crystalline, and in case it is composed wholly of substances whose diffraction patterns are known.

Q. And, in order that their diffraction patterns may be known, what is essential?

A. In order that their diffraction patterns may be known, the diffraction pattern must be—the diffraction pattern must have been obtained from a chemically known, pure crystalline material.

Q. Otherwise, you would be putting a name to what?

A. Otherwise, we would be asked to put a name to an unknown material.

THE COURT: Now, don't you think he had better go on with his notes?

By MR. MORRIS:

Q. Will you proceed with your answer to the remainder of my question, please?

A. Well, we have shown—

THE COURT: Don't you want to read it? I thought it was a pretty good way to do it.

THE WITNESS: Oh, no. I was almost done.

(Discussion off the record.)

THE WITNESS: It has, therefore, not been

shown by X-ray methods that there is or ever has been any  $\text{Pb}_2\text{O}$ , if such a material exists at all, in the Exide oxide because there is no authenticated  $\text{Pb}_2\text{O}$  to use as a starting point as a standard diffraction pattern.

By MR. MORRIS:

Q. Does that complete your answer?

A. Yes, sir.

Q. Have you examined the X-ray data offered in evidence by the Plaintiffs and, if so, with what result?

A. I have examined the X-ray data offered in evidence by the Plaintiffs. In so doing, I had the following in mind:

A. though I had satisfied myself that no standard diffraction pattern was known for the so-called  $\text{Pb}_2\text{O}$ , Dr. Clark had testified that he believed he had reason to assume that a real  $\text{Pb}_2\text{O}$  would be cubic and would have a cuprite type of structure.

By THE COURT:

Now, just let me interrupt you there to recall to me what the cuprite structure is. It is different from cubic?

A. The cuprite structure is a face-centered cube, having one kind of atoms in this species  $\text{Pb}_2\text{O}$ —in this species  $\text{Pb}_2\text{O}$ , it would be a face-centered cube—then along one of the body diagonals there will be two atoms of oxygen, one of them a quarter of the way along the body diagonal and the other three-quarters of the way along. That structure represents one-eighth of the total unit of the cuprite structure, the other seven-eighths differing from this only in the choice of the body diagonal used.

Q. All right. Then, it is cubic because it is composed of eight cubes. It is composed of eight cubes, you say?

A. No. I have described one-eighth of the structure, but—

Q. Well, as a—

A. —the other seven-eighths is very similar to it.

Q. Well, the whole thing is composed of eight cubes, all together?

A. Yes, and those eight cubes make the smallest quantity in a crystal cuprite that you can have.

THE COURT: All right.

By MR. MORRIS:

Q. Have you finished your difference between a face-centered cubic type and a cuprite structure?

A. Yes, I have answered the Judge's question.

THE COURT: Yes, I understand.

By MR. MORRIS:

Q. I didn't get from your answer, with the clarity with which you have told me before, the difference between the face-centered cubic type of structure and the cuprite structure; and, consequently, I want to ask you if you can have a cuprite structure without first having a face-centered cubic type of structure?

A. If a cuprite structure is a—is composed of two crystal lattices, one of these two crystal lattices is a face-centered cubic lattice and is the one of the cuprite; and, in the case of the specious  $\text{Pb}_2\text{O}$ , the lead is found on the other lattice and is center-leaved with this face-centered cubic lattice of lead in the way that I have described.

Q. Then, won't you have my question read to you and tell me whether the answer is yes or no, Dr. Davey?

(The question was then repeated by the reporter, as follows:

"Q. I didn't get from your answer, with the clarity with which you have told me before, the difference between the face-centered cubic type of structure and the cuprite structures; and, consequently, I want to ask you if you can have a cuprite structure without first having a face-centered cubic type of structure?")

THE WITNESS: In having a face-centered—in having a cuprite structure, you must have a face-centered cubic type of diffraction pattern—one of the two types or kinds of atoms composing the cuprite structure.

By Mr. MORRIS:

Q. Then, if I understand you right, Dr. Davey, tell me if I am wrong, won't you, you cannot have a cuprite structure unless you have a face-centered cubic type of diffraction pattern, or have I gone wrong on the diffraction pattern?

A. If you have a cuprite structure composed of two kinds of atoms, one of higher atomic number than the other, and if the one having the higher atomic number is on the face-centered cubic lattice, then the cuprite structure necessarily gives a face-centered cubic diffraction pattern.

Q. All right. Now, then, will you proceed with your answer, Dr. Davey? It is my mistake, as usual.

A. Well, I had—



THE COURT: I think he said he was through.

MR. MORRIS: No. No, that's the second question.

THE WITNESS: —I had just finished saying that Dr. Clark testified that he believed, he had reason to assume, that a real  $\text{Pb}_2\text{O}$  would be cubic and that it would have a cuprite type of structure; thus giving a face-centered cubic type of diffraction pattern.

I have known Dr. Clark for many years. He is a scientist of reputation, and I felt that I should cover the possibility that I had overlooked some bit of evidence which was, perhaps, perfectly obvious to him. So I pretended that there was a real compound,  $\text{Pb}_2\text{O}$ , and I pretended it had a cuprite structure with a lattice parameter of either 3.38 Angstroms, according to Ferrari. :

By MR. MORRIS:

Q. But, Dr. Davey—

A. May I just finish that?

Q. —but that a sub zero line of Ferrari was what?

A. 3.38.

Q. Won't you check your memory on that?

A. You are quite correct, Judge, as usual. It is 3.38.

Q. All right.

A. Going back, then, in my notes—is it permissible, Judge, to make these corrections as we go along without messing up the record?

THE COURT: Sure, it is.

: THE WITNESS: At that part, where I said "So I pretended that this was a real compound,  $\text{Pb}_2\text{O}$ ,

and that I pretended it had a cuprite structure . . . —

(Part of the answer referred to was then read by the Reporter, as follows:

"A. . . . and I felt that I should cover the possibility that I had overlooked some bit of evidence which was, perhaps, perfectly obvious to him. So I pretended that there was a real compound,  $Pb_2O$ , and I pretended that it had a cuprite structure with a lattice parameter of either—")

THE WITNESS: Right there. —5.38 Angstroms according to Ferrari, or 5.32 Angstroms according to Clark.

By MR. MORRIS:

Q. Yes. Go on.

A. I then hunted for evidence of this pretended structure in all the X-ray data submitted by the Plaintiffs. This search was conducted by the well-known slide-rule method described in the literature and in my textbook, "A study of Crystal Structures and Its Applications", on pages 126, 127, 128, and mentioned by Dr. Clark in both editions of his book.

Unless the Court wishes otherwise, I shall assume that the theory and technique of the slide-rule method of interpretation are sufficiently described by the above reference to my book and shall merely say that by this method a face-centered cubic type of diffraction pattern is demonstrated when an exact match is found between lines of the actual experimental diffraction pattern, plotted on a slide-rule, and lines marked in certain definite positions on the inverted slides of the slide-rule.

I have examined in this way each of the four sets of experimental data submitted in evidence by the Plaintiffs. If I may have those four slide-rules (indicating), I can demonstrate what I have done.

Q. All right, here they are (tendering).

A. I have marked on this slide-rule, in pencil, on the lower scale the diffraction pattern of one of the—

Q. Just a moment. Will you begin again? You have marked on this slide-rule what?

A. On the lower scale, in pencil, the diffraction pattern from one of the sets of data submitted by the Plaintiffs. On the inverted slider, I have marked the lines representing a theoretical face-centered cubic diffraction pattern. I should like to show that we have, within a quarter of one per cent, an exact match for certain lines which I have marked on this slide-rule with a cross mark (indicating).

THE COURT: Yes.

THE WITNESS: The lattice parameter of 4.92 corresponds.

By MR. MORRIS:

Q. That's 9.2 Angstroms units.

A. That is 9.2 Angstroms units, yes, and it corresponds to the lattice parameter of metallic lead. I should like to call your attention to the exactitude of the match.

THE COURT: Yes.

THE WITNESS: As nearly as I can determine, the match is accurate to within one-quarter of one per cent.

THE COURT: Of certain lines?

THE WITNESS: Sir?

THE COURT: Not all lines but of certain lines?

By MR. MORRIS:

Q. What lead lines?

A. In the neighborhood of about one and half Angstroms, which we take as a sort of standard position. The line which is furthest out is out by about a quarter of a per cent.

Q. Those lines represent what?

A. Interplanar spacings.

By THE COURT:

Q. Of what?

A. Of the metallic lead reported by the Plaintiff.

Q. Which specimen was it?

A. It ~~was~~ the one which we were led to believe belonged to Exide oxide. It's the one which is not—C-83—drawn with two complete diffraction patterns.

(Discussion off the record.)

THE WITNESS: It was the first paper submitted by Dr. Clark. Have you the photostats?

(Discussion off the record.)

By MR. MORRIS:

Q. Yes, Defendant's 2. It was the first paper submitted by Dr. Clark. Have you the photostats, now, of the slide-rule in that position?

A. I have here a photograph, a copy of a photograph, of the slide-rule in that position.

Q. Did you speak of the lines on the bottom of the rule, having a line across them?

A. The lines on the bottom of the rule which have the cross mark on them are the lines which show the exact match of the theoretical face-centered cubic pattern for lead.

Q. And this photograph shows the rule in the position in which you just demonstrated it?

A. It does.

MR. MORRIS: That is offered in evidence as Defendant's Exhibit 126.

(Copy of said photograph was then marked as Defendant's Exhibit No. 126.)

By MR. MORRIS:

Q. Now, you have a notation on that photograph—not on your slide-rule but on your photograph—and will you read us what it is?

A. Can I get the photograph?

THE COURT: Oh, is it necessary to read it?

MR. MORRIS: Perhaps not. The other side has not seen it, and I would like to have them see it.

By MR. MORRIS:

Q. All right, you may proceed.

A. On this same slide-rule I have now set the inverted slider to correspond with the theoretical diffraction pattern of a face-centered cube of lattice parameter of 5.30, that is, to the lattice parameter of the face-centered cube preferred by Ferrari.

I should like to demonstrate the lack of a systematic match of the experimental data submitted by the Plaintiffs with the theoretical diffraction pattern for Ferrari's so-called  $\text{Pb}_2\text{O}$  (exhibiting).

Q. The photograph of the rule in that position—

A. This is the photograph of the ruler in that position.

THE COURT: That's what, exhibit what?

MR. MORRIS: 127. I offer this to be marked as the Defendant's Exhibit 127.

(Said photograph was then marked as Defendant's Exhibit No. 127.)

THE COURT: That's the Defendant's Exhibit 127. You offered that in evidence?

MR. MORRIS: I offered that in evidence, and at the conclusion, or sometime, I want to have them all—all that I have offered—accepted in evidence or, perhaps, ruled upon because—unless your Honor's practice is to admit them and no objection is made.

THE COURT: That's my practice, yes, if offered in evidence. Yes.

(Discussion off the record.)

THE WITNESS: You will notice, Judge, that there are a few accidental coincidences here and there, but there is no regular coincidence such that every line in the theoretical pattern is represented by a line in the experimental pattern.

DR. CLARK: I have done it myself, yes.

THE COURT: Well, now—don't put this down.

(Discussion off the record.)

THE COURT: Here are the two. That's what he wants, the two photographs.

THE WITNESS: I have not set the slider on the slide-rule to correspond to a lattice parameter of 5.33, which was Dr. Clark's preferred lattice parameter for the so-called  $\text{Pb}_2\text{O}$ , and I should like to demonstrate to the Court by this slide-rule.

that, again, there is no systematic match between the face-centered cubic diffraction pattern to be expected from such an interpretation and the actual experimental data submitted to the Court; and the photograph of that I now hand you.

MR. MORRIS: The photograph of that, I now offer in evidence as the Defendant's Exhibit 128.

(Said photograph was then marked as Defendant's Exhibit No. 128.)

(Discussion off the record.)

By MR. MORRIS:

Q. Dr. Davey, will you tell me, please, what the failure of those lines to match, when you assume a parameter of 5.38 Angstroms units, and 5.33 Angstroms units as indicated by Ferrari and by Dr. Clark, respectively, proves?

A. That means that, insofar as can be determined by crystal analysis methods, the Exide oxide contained neither Ferrari's version of the so-called  $Pb_2O$  nor Clark's version of the so-called  $Pb_2O$ .

Q. Well, does it mean anything further in the way of cuprite structure or face-centered type of diffraction pattern, or anything of that character or order?

A. I have tried systematically to find some position of the slider whereby I could get a match with a face-centered cube.

By THE COURT:

Q. You get the best match for lead, don't you—ordinary lead?

A. The only match we get is for lead.

Q. Yes.

A. I have tried systematically to get matches. I



have taken the first line of the theoretical pattern and have tried it on the first line of the diffraction pattern, excluding the lead lines; I have tried it on the second one and I have tried it on the third one.

I have tried to get matches on the second line, on the ground that, possibly, Dr. Clark might have missed a line up in here somewhere (indicating.) I have done that on all reasonable ranges of lattice parameter.

Q. Don't you get any PbO—any correspondence?

A. PbO? I suppose you mean red PbO, don't you?

Q. Yes. This thing in here (indicating)—tetragonal litharge?

A. The diffraction pattern for tetragonal litharge is not a face-centered cubic pattern, and would require lines on different positions on the slider from where I have put them.

By Mr. MORRIS:

Q. What inference, Dr. Davey, do you draw from the fact that you have the lines that match for the lead to within one-quarter of one per cent, as you estimated, and you don't have other lines for the other products that match within whatever percentage you may have determined? I think that's a complete question.

A. The inference is that experimental conditions were such that Dr. Clark was able to make a very precise measurement of the positions of the lines in this diffraction pattern. Otherwise, his lead lines would not have matched the theoretical lines so beautifully. Apparently, he had an excellent diffraction pattern to work with.

Q. Within a like degree of certainty, to wit, one-fourth of one per cent, or accuracy with respect to the lines?

A. Other than his lead lines?

Q. Yes.

A. I assume that he had such accuracy, except in the case of such lines that were too weak to place with certainty in any position.

Q. Your failure to match those lines with a parameter of 5.38 of Ferrari and with a parameter of 5.33 of Dr. Clark, tell us why that is.

A. My interpretation of that is that there is no material in the Exide oxide corresponding to this material which the Plaintiff claims is  $Pb_2O$ .

I have here a photographic record of numerous attempts to make matches between the two patterns, other than in the case of lead.

(Discussion off the record.)

MR. MORRIS: Now, I offer those photostats, twelve sheets, in evidence as the Defendant's Exhibit 129.

(Twelve photostats marked as the Defendant's Exhibit No. 129.)

(Discussion off the record.)

THE COURT: Well, you want to finish that.

THE WITNESS: Yes. The record shows that I have been unable to make any match with the face-centered cubic pattern except in the case of metallic lead.

By MR. MORRIS:

Q. Will you proceed from there, Dr. Davey, please?

A. I have made similar tests of the Plaintiffs' data, submitted as C-83.

Q. I hand you that exhibit (tendering). Do you want to refer to it as that Plaintiffs' number?

A. Plaintiffs' No. 59, yes. Do you want these marked?

Q. It's the Plaintiffs' Exhibit 59. Will you proceed to tell us what results you have found?

A. I have marked on the slide-rule the data of Plaintiffs' 59, and on the inverted slider I have marked the theoretical face-centered cubic diffraction pattern. I find a face-centered cubic diffraction pattern of lattice parameter of 4.92, corresponding to that of metallic lead. The match between the experimental data and the theoretical data is, again, most excellent. I estimate it to be a match within a quarter of a per cent, as before. ¶

I have now set the slider—do you want to give that? This is the one I have just finished.

Q. The rule is set—the rule as set and as last testified to by the witness was photographed?

A. Yes.

MR. MORRIS: And the photograph of the rule in that setting, I offer in evidence as Defendant's Exhibit 130.

(Said photograph was then marked as the Defendant's Exhibit No. 130.)

(Discussion off the record.)

THE WITNESS: I have now set the slider on the slide-rule to correspond to the theoretical diffraction pattern of a face-centered cube of lattice parameter of 5.38, corresponding to the cuprite structure of Ferrari. As in the case of the previous set of data, there is no systematic match between the data submitted and the theoretical face-centered cubic diffraction pattern of lattice parameter of 5.38.

THE COURT: All right.

(Discussion off the record.)

By MR. MORRIS:

Q. Do you have a photograph of that?

A. I do.

(Discussion off the record.)

MR. MORRIS: I offer the photograph of that setting in evidence as the Defendant's Exhibit 131.

(Said photograph was then marked as Defendant's Exhibit 131.)

MR. WHITCOMB: Your Honor, I suppose you want anything we have to say about it to be held for rebuttal?

THE COURT: Yes.

MR. WHITCOMB: Dr. Clark thinks he has omitted three-fourths of the lines.

THE COURT: All right. Go ahead.

THE WITNESS: I should be glad to have Dr. Clark check the slide-rules with the data which he has submitted. Here's the first one I have used if he wants to try it.

MR. WHITCOMB: It's not the slide-rule; it's the data.

THE WITNESS: The data? I can't help that.

(Discussion off the record.)

THE WITNESS: The first figure given under the column D on the Plaintiff's 59 exhibit is 3.423. The first line on the slide-rule is 3.42 and a fraction, which is intended to be three within the width of a pencil mark.

The second line on the data sheet is 3.096, and the second line on the slide-rule is 3.096 within the precision of the width of a pencil mark.

The third figure on the data sheet is 2.840; the corresponding line on the slide-rule is 2.840.

The next one on the data sheet is 2.788. I find the 2.788 is on the slide-rule.

The next one is 2.738, and I find 2.738 on the slide rule.

The next figure is 2.609, and I find 2.609 on the slide-rule.

The next figure is 2.510. I find a 2.510 on the slide-rule.

The next figure is 2.461, and I find the 2.461 on the slide-rule.

The next figure is 2.199—

DR. CLARKE: Pardon me, just a minute. Are you trying to fit every single one of those numbers into the face-centered cubic lattice?

THE WITNESS: No. I am trying to find anything which I can pick out from that—that I can fit into a cube, or a face-centered cube lattice—and the only lines I have been able to pick out, by the way, are those of lead.

DR. CLARK: They are beta.

THE WITNESS: If they are beta lines, they are not—if you should have beta lines, you should have had some alpha lines.

(Discussion off the record.)

THE WITNESS: We made no alibies for the data. We plotted everything that was submitted as evidence and, if there are any beta lines here, we have increased your chance of finding a match

with some theoretical pattern because, in that case, we have put in some additional lines rather than taking them out.

(Discussion off the record.)

By MR. MORRIS:

Q. I don't seem to remember what this tabulation for Plaintiffs' Exhibit 59 is for. Do you recall, off-hand?

A. I have never been able to find out from the testimony what C-83 meant. Either my memory is poor or it was not brought out clearly, so that all I can tell you is it is a diffraction pattern of something.

MR. WHITCOMB: Oxalate.

THE WITNESS: Oh, yes; C-83 is oxalate.

By MR. MORRIS:

Q. That is C-83, which is Plaintiffs' Exhibit 59. Will you proceed, Dr. Davey, please?

A. Continuing our experiments with the slide-rule, I have set the slider to show the theoretical diffraction pattern—excuse me—I have set the slider of this slide-rule to show the theoretical face-centered cubic diffraction pattern corresponding to a lattice parameter of 5.33, which is Dr. Clark's preferred parameter for  $\text{Pb}_2\text{O}$ .

THE COURT: I think they want to relay stenographers at this point, and we will now have a little recess.

THE WITNESS: I should like to submit the slide-rule with the slider in this position to demonstrate that there is no systematic coincidence between the experimental data or any portion

thereof and Dr. Clark's version of the theoretical structure for  $\text{Pb}_2\text{O}$ , so-called.

By MR. MORRIS:

Q. Have you a photograph of the rule in that position?

A. I have.

MR. MORRIS: I offer the photograph in evidence as Defendant's Exhibit 132.

(Photograph of slide-rule calculation of the witness Davey was marked Defendant's Exhibit 132.)

By MR. MORRIS:

Q. Will you proceed?

A. As before, I have made systematic attempts to find matches of a face centered cubic diffraction pattern on the data from this data sheet as submitted by the plaintiff.

THE COURT: Which is this C83?

MR. MORRIS: Plaintiffs' Exhibit 59, referred to sometimes as C83.

THE WITNESS: C83, yes.

By MR. MORRIS:

Q. All right, with what result, Dr. Davey?

A. Using any reasonable limits on each side of the lattice parameters used by Clark and Ferrari, I can find no systematic match. These photographs are photographs of the slide-rule in the positions for such tests.

MR. MORRIS: I offer those photographs in evi-



dence; being fifteen sheets, as Defendant's Exhibit 133.

(Photographs of slide-rule demonstrations by the witness, Davey, were marked Defendant's Exhibit 133.)

By MR. MORRIS:

Q. What is your conclusion from the facts which have been testified to by you with respect to your inability to obtain a match from the data submitted by plaintiff in this case?

A. From the two diffraction patterns taken up so far in this testimony the conclusion is that no—the conclusion is that there has been no demonstration on the part of the plaintiff of the presence of the diffraction pattern which they attribute to  $Pb_2O$  in either of the two materials which they have investigated.

By THE COURT:

Q. That is, even the pattern isn't there?

A. Even the pattern isn't there.

Q. The thing that they said anybody could see does not—

A. Correct.

Q. —exist?

A. That I believe I have demonstrated sufficient to the Court. I have here—

MR. MORRIS: Just a moment.—

By THE COURT:

Q. Now, I just want to get that clear in my mind. Now, this testimony is going to the effect that these lines are not where Dr. Clark said they were, is that what it amounts to?

A. That is about what it comes to.

Q. That actual measurement shows that those lines are not where he said they were?

A. Yes.

Q. In this strip of film?

A. Correct.

By MR. MORRIS:

Q. Now, Dr. Davey, maybe I didn't understand this—

THE COURT: Well, but, now, everybody shakes their head when I say that, except the witness, and he says that is correct.

MR. MORRIS: Well, I don't know just what he means by that, it may be correct, I don't know.

THE WITNESS: I don't mean, Judge, that the lines are not where the data sheets say they are, I mean that the lines are not where his interpretation of the data sheet would call for them to be.

THE COURT: Well, unfortunately.—

THE WITNESS: That doesn't answer the question—

THE COURT: —I don't understand it, I don't understand that answer.

By THE COURT:

Q. This is what he sees, isn't it?

A. Yes.

Q. That is the think he actually sees (indicating). Now, does your testimony go to the effect that his measurements are wrong that he took on the data sheet?

A. No, my testimony says nothing about—

Q. All right, I want to understand: that is not your testimony?

A. I haven't testified that his measurements are incorrect.

Q. When he measured the location of these lines he measured them correctly?

A. I think I know Dr. Clark well enough to—

Q. In other words, you—

A. —take it for granted—

Q. All right.

A. —that the measurements he has made and recorded there are measurements from that film.

Q. All right.

A. But he has given an interpretation of his measurements, namely,—

Q. By saying that they correspond?

A. —by saying that he has a diffraction pattern corresponding to a cuprite cube.

Q. All right.

A. That is, that he has found a face centered cubic diffraction pattern which he interprets as representing a cuprite cube of  $\text{Pb}_2\text{O}$ . I have shown that taking either Ferrari's data or a cuprite cube or Clark's own data for the cuprite cube that the data which he has presented does not match the theoretical data for either of those two, for the diffraction pattern from either of those two supposed cuprite cubes.

Q. Well, then, what was wrong, was he wrong in placing the lines on his standard, or was he wrong—you say he was not wrong in placing it on the patterns that he got?

A. No, I give full faith to the—to the experimental evidence.

Q. Well, did Dr. Clark say—

A. I think he has fallen into error in his interpretation of his data.

Q. I wish you could make it—

A. I have here another slide-rule which I think will bring that out a little more fully.

Q. I was going to say I wish you would make that a little clearer to me.

By MR. MORRIS:

Q. And now, please, Dr. Davey, may I try just for a moment to see whether I can get it, because I haven't it any clearer than your Honor has, if anywhere nearly so clear.

THE COURT: Well, I believe you have, Judge.

MR. MORRIS: No, sir, but I am going to try to get it, wherever it falls.

By MR. MORRIS:

Q. If I understand you aright, Dr. Davey, you accept Dr. Clark's measurements as he had handed them to us?

A. I certainly do.

Q. You start from there?

A. Yes, sir.

Q. On the assumption that they are correct,—

A. Correct.

Q. —that he measured accurately?

A. Yes, sir.

Q. Now, then, if I understand you aright, and I don't know that I do, but if I do, you take those measurements and find whether you can find in those measurements evidence of a cuprite structure?

A. Correct.

Q. And you do or do not find it,—

A. I do not find it.—

Q. —from those papers?

A. —any evidence of a cuprite structure in the measurements which he has submitted.

THE COURT: Surely, I understand that, that far, I understand all along, that is just the begin-

ning, but you speak of correspondence with a theoretical structure.

THE WITNESS: Yes.

BY THE COURT:

Q. Now, where did you get that theoretical structure with which you cannot find any correspondence, and Dr. Clark can find correspondence?

A. Well, Dr. Clark has testified that his so-called  $Pb_2O$  must have the cuprite structure, and he has submitted to the Court a photograph of a model of that structure.

Q. Yes.

A. Now, granting the configuration of atoms in that model, and taking for the edge of the unit of structure in that model the value of 5.338, it is possible to calculate what the interplanar spacings in that model should be.

Q. All right, now, that is what you did?

A. That is what I did,—

Q. And you found no correspondence?

A. —and there is no correspondence.

Q. Well, now, what did he do?

A. Well, I hope with the next two slide-rules to show what we think he did.

Q. Well, the slide-rules don't help me.

A. Because he has submitted two other lots of data.

Q. Well, all right,—

A. Or, rather, two data sheets.

Q: I would like to know what he did, in other words, where the difference comes in. It is a general statement, I understand that you are saying he misinterpreted his data, and that you do not place the same interpretation, but you found a certain lack of correspondence—

A. Yes.

Q. —between those and a theoretical cuprite structure. Now, did he find an exact correspondence, or a fairly exact correspondence, or didn't he try?

A. I think he did try.

Q. You say—

A. This is opinion, now, not fact.

Q. No, but is there anything in his testimony to indicate that he did or did not, or tried to do it?

A. His testimony indicated, and the examination of his data indicated that he picked certain lines as corresponding to the diffraction pattern of his so-called  $\text{Pb}_2\text{O}$ .

Q. Well, now, did his—

A. And that he has—

Q. Well, now, what is wrong with it, did he pick the wrong lines, or don't they correspond when he says they do?

A. I am inclined to think that he picked the right lines but they do not correspond within the precision of his measurement to what is required for the structure which he thought he had. He must allow himself an experimental error for those lines many times in excess of the experimental error which he evidently has for his lead. Before he can account—

Q. Well, then, the difference—

A. —for the differences—

Q. All right.

A. —between the diffraction pattern and the theoretical.

Q. The difference, as I understand is, is that he missed—this is all your interpretation, but that he missed this correspondence by so wide a margin that you say it cannot be the same thing. He agrees with you that he missed it by that margin, but says that is a fair percentage of lack of precision?

A. I think that is a very fair statement.

THE COURT: Well, all right.

By MR. MORRIS:

Q. Now, I bring your attention to Dr. Clark's testimony of this morning, if that is of any service to you in this connection, I don't know whether it is or not,—

THE COURT: I am just trying to get at where you say he is wrong, and I think I understand now.

THE WITNESS: Dr. Clark this morning—

THE COURT: I hope I don't get thrown off again—what?

THE WITNESS: Dr. Clark this morning attempted to account for this discrepancy which he undoubtedly knew was there in terms of a distortion of his crystal lattice.

THE COURT: Yes.

THE WITNESS: He avoided the use of the word "solid solution", but his testimony very plainly stated to anyone who has studied solid solutions that he assumed a—that he assumed the possibility of a continuous solid solution of oxygen in lead, all the way from a negligible amount in pure lead up to an amount approaching that of  $PbO$ . The minute that he has assumed that he has, of course, vitiated his original testimony as to the existence of a definite compound,  $Pb_2O$ .

THE COURT: Well, I understood that.

THE WITNESS: Because he has no definite—

THE COURT: Well, all right, I didn't want to get mixed up any more.

THE WITNESS: Does that satisfy you?



THE COURT: I have got a grasp of something now.

THE WITNESS: Does that answer your question?

THE COURT: Yes, that is all right.

By MR. MORRIS:

Q. Now, will you pass to your other slide-rule tests, please?

A. Now, the next slide-rule test is in connection with the Plaintiffs' Exhibit 53, which gives a set of X-ray diffraction data on the fractionated Exide sample corresponding to 9, 10 and 11.

Q. Plaintiffs' Exhibit 21?

A. Plaintiffs' Exhibit 21.

By THE COURT:

Q. Well, may I just go back again, if you agree that Dr. Clark found the same discrepancies that you find what is the use of all this slide-rule business?

A. I am trying to make it a matter of record.—

Q. Well, but you say—

A. —how great the discrepancies are.

Q. Well, but you say he has agreed to that.

A. He has mentioned that there are discrepancies in one line this morning.

Q. Yes.

A. I am trying to show there are discrepancies all the way through his pattern and I am trying to demonstrate how great those discrepancies are.

Q. All right.

A. I have marked on the body of the slide-rule the data in the last column of Plaintiffs' Exhibit 53.

Q. 53?

A. His Exhibit 53 gives his diffraction data from certain—

Q. Exide samples?

A. —Exide samples, and Ferrari's data, and data from a co-worker of Dr. Clark's by the name of Schieltz, and it is Schieltz's data that I have recorded on the slide-rule.

Now, I want to call your attention to a peculiarity of the lack of match here. I am now making a match between the first theoretical line and the first experimental line. You will notice that the second experimental line is too small, readings to the left are smaller than readings to the right.

The third line is too small.

The fourth one gives a very good match.

The fifth one is too small.

The sixth one is too small.

The seventh one does not match at all.

The eighth one is too small.

The ninth one is too small.

The tenth one does not match at all.

The eleventh one is too large.

And the twelfth one is too large.

Now, the amount of error which would be required in order to justify pushing those experimental lines up to a more exact match is many times the experimental error which we have seen is inherent in his readings of his films.

We can make a similar attempt by making our correspondence between the second theoretical and the second experimental line, and you see that we are no better off. If we try down on the 1615 line we are no better off, and so on.

By MR. MORRIS:

Q. Have you a photograph?

A. I have a photograph of the slide-rule in that position for Ferrari's lattice parameter and in the position for Clark's lattice parameter.

Q. The first being Ferrari, and the second for Clark?

A. Correct.

MR. MORRIS: The first I offer in evidence as Defendant's Exhibit 134, and the second, being Dr. Clark's, I offer in evidence as 135.

(Photograph of slide-rule for Ferrari's lattice parameter, produced by the witness Davey, was marked Defendant's Exhibit number 134.)

Photograph of slide-rule in the position for Clark's lattice parameter, produced by the witness Davey, was marked Defendant's Exhibit number 135.)

THE WITNESS: There was still a fourth data sheet submitted by the plaintiff, which was labeled with the words "Highest accuracy". I assume therefore, that this represents the best possible data, or the combination of the best possible data for the so-called  $Pb_2O$ . I have now set the diffraction pattern—I have now set the theoretical diffraction pattern to correspond with Ferrari's lattice parameter, and the highest accuracy data of the plaintiff do not correspond to the theoretical pattern.

THE COURT: Doesn't hit anything.

By MR. MORRIS:

Q. That has a parameter of 5.38?

A. 5.39. I now set the slider—I now set the slider for the lattice parameter of 1.533, and wish to demonstrate again a lack of correspondence of the plaintiffs' highest accuracy data with the theoretical diffraction pattern.

Q. Don't change your rule, please. What is your lattice parameter on there?

A. My lattice parameter is 5.33.

Q. So you were inaccurate a moment ago when you said 1.33?

A. Did I?

THE COURT: Yes.

THE WITNESS: I am very sorry. I intended to say 5.33.

MR. MORRIS: Very well.

By MR. MORRIS:

Q. In your previous setting you said 5.39. I am wondering whether you had it 5.39, or whether you had Ferrari's dimension.

A. 5.39 is Ferrari's dimension.

Q. No, you know we had that discussed a while ago. Won't you turn to Ferrari and refresh your recollection?

A. Excuse me, 5.38, you are quite right.

Q. You had it set—

A. 5.38.

Q. —at 5.38?

A. Yes.

By THE COURT:

Q. This parameter is the same as the "a sub zero" thing?

A. Yes, "a sub zero" is the lattice parameter.

Q. Yes.

A. Now, the testimony on behalf of the plaintiff this morning indicated that these discrepancies were to be interpreted in terms of amounts of oxygen in the crystal differing from the ratio of oxygen to lead required by the chemical formula  $Pb_3O_4$ .

By MR. MORRIS:

Q. Which would distort, but would not change—

A. Which it was claimed would distort a lattice.

Q. But would not change—

A. But would not change its essential nature.

Q. Yes.

A. I have examined the diffraction pattern, as it stands by a method similar to the slide-rule for other types of crystals than the cubic type, and I have been able to find at least as good a match in the tetragonal system, at least as good a match with the rhombohedral system, at least as good a match with the hexagonal close packed type of crystal. This leaves the plaintiff, I think, with an embarrassing freedom of choice as to what sort of distortion they may have in this hypothetical material  $Pb_2O$ .

If I remember correctly this morning's testimony dealt with the lack of coincidence for a line in the neighborhood of 1.66. Is that correct, or was it 2.66? Dr. Clark says it is 2.66.

I should like to call the attention of the Court to the fact that not only is 2.66 out of position as required by the theoretical diffraction pattern, but that every other line in the diffraction pattern is out of position except the first one, namely, 1—namely, excuse me, 31, practically one—09, I think it was, wasn't it? In order to get a match for the lines in the diffraction pattern of relatively small interplanar spacings it is necessary to move the slide-rule up bit by bit until a match has been obtained first with the line at one, at approximately 1.935, then move it still more to get a coincidence with the next, for the next two lines, then move it backwards to a coincidence with the next two lines.

Of course, if we assume that we can have any amount of oxygen present, so that we get a continuous distortion of the crystal from metallic lead up to some form of  $PbO$ , then there is no obedience to the law of definite proportions, and, therefore, no evidence of a

chemical compound at all. Solid solutions are not limited to the illustrations which—

By THE COURT:

Q. What is the law of definite proportions?

A. Sir?

Q. What do you mean by the law of definite proportions?

A. It is the fundamental law of chemistry, it is the definition of a chemical compound, that is a chemical compound the elements are present in definite proportions.

A. Sir?

Q. What do you mean by the law of definite proportions?

A. It is the fundamental law of chemistry, it is the definition of a chemical compound, that is a chemical compound the elements are present in definite proportions.

Returning to my previous sentence, examples of solid solutions are not at all limited to those which were given this morning. Solid solutions have been well known to metallurgists for years, and most of our useful alloys are solid solutions.

Q. What is a solid solution? What significance has that term in this?

A. In a solid solution the atoms of the solute either occupy positions which would have been occupied by atoms of the solvent, or else occupy intermediary positions, pushing the atoms of the solvent somewhat out of their normal places. I might illustrate it this way: a solid solution has the same relation to the solid state that a solution of one liquid in another liquid has to the liquid state. A solid solution represents one solid dissolved in another solid, just as one liquid can be dissolved in another liquid, —

MR. WHITCOMB: If your Honor please,—

A. —or just as a solid can be dissolved in a liquid.

MR. WHITCOMB: —I wanted to make a statement because the witness said something about us purposely avoiding it. That is, in our rebuttal, we are going to talk about in rebuttal.

THE COURT: What is that?

MR. WHITCOMB: The solid solution proposition.

THE WITNESS: Well, if you wish, Mr. Whitcomb, I am defining the state of affairs illustrated in this morning's testimony by the word "solid solution", which is the ordinary—the statements this morning are the ordinary conception of what a solid solution is.

BY MR. MORRIS:

Q. Dr. Davey, won't you turn to page 1134 of the testimony before you, which is the transcript of Dr. Clark this morning, and I thought you used a moment ago in your calculation  $\text{PbO}_{2.66}$ , and I have sent for the testimony to see, and I may be wholly in error as to what you were referring to, but that seems to be sub 1.66.

A. I am afraid we are not talking of the same thing.—

Q. All right.

A. —Judge Morris.

Q. Very well.

A. I was talking of the interplanar spacings corresponding to the lines in his sheet representing, labeled highest accuracy.

Q. Very well.

A. And not referring to any subscripts of any suppositious compounds having fractional proportions.



Q. At the moment I thought you were asking Dr. Clark as to whether he referred in that particular instance to a subscript of 1.66 or 2.66.

A. No.

Q. I was in error.

A. I was referring to the interplanar spacings.

THE COURT: I wonder if we could come to about the point of adjourning now.

MR. MORRIS: Of course, at your Honor's convenience. Dr. Davey must, of course, go into his examinations of these Exide, or defendant's product, and the Toronto product.

THE COURT: Oh, yes, of course he must, and I am wondering whether all this testimony so far, it is certainly awfully irregular to have one witness criticize the testimony of another witness, but I thought it was all right, and it is all right, it is really helpful, except that we are going to get possibly an almost endless chain, because Dr. Clark will now take up Dr. Davey's testimony on the stand, and I wonder where we are going to stop. It wasn't objected to, it wasn't objected to. Of course, it is a very unusual form of expert testimony.

MR. WHITCOMB: Well, we did attempt to make—we made an objection.

THE COURT: No, you didn't make that objection, you asked whether he was stating a harangue about Dr. Clark. I didn't understand you—

MR. WHITCOMB: That was a form of objection—

THE COURT: What?

MR. WHITCOMB: I intended that to be in the form of an objection.

THE COURT: It wasn't very clearly put, if it was.

(Discussion off the record.)

MR. BETTS: I ask that we may reserve the right to move to strike any part of Dr. Davey's testimony.

THE COURT: All right, we will meet that when it comes up. It is a matter of discretion, anyway.

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Adjourned until Tuesday, October 8, 1936, at ten o'clock A. M.

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DEFENDANT'S EVIDENCE (Continued).

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MR. BETTS: May it please your Honor, the parties have a stipulation to read in the record.—

THE COURT: All right.

MR. BETTS: —as follows. It is stipulated that defendant paid the expenses of the Interference proceedings between Hall and Shimadzu, the record of which is marked Plaintiffs' Exhibit 41

MR. MORRIS: It is so stipulated.

WHEELER P. DAVEY, recalled.

*Direct-examination (Continued).*

By MR. MORRIS:

Q. Dr. Davey, have you made any X-ray diffraction patterns of certain official specimens and other specimens in connection with this litigation?

A. I have.

Q. What specimens did you examine, and what results did you find?

A. I received a series of samples to which I gave serial numbers, which were sent to me under serial numbers in a letter of transmittal, and which had on the containers the description which I shall read in connection with these. My serial number 1, serial number in letter of transmittal, 1, wording of label—

THE COURT: Now, wait a minute, let me have 21, again, Plaintiffs' 21.

(Discussion off the record.)

By THE COURT:

Q. All right, now, go ahead, your serial number 1 and letter of transmittal 1 was what?

A. Official sample gray oxide, run number 21, mill number 1.

By MR. MORRIS:

Q. That would be presumably the same as 6 on there?

A. Same as 6, yes. Time, 1.30 P. M.; finished product May 25, 1934.

THE COURT: Well, without going into that, is it agreed that that would be the same as number 6 on 21, that is, what is labeled Exide oxide here?

MR. MORRIS: May I put it this way? I think they will probably stipulate this wise, that what Dr. Davey is speaking of now is a test or is an examination of one of the samples of defendant's product,—

MR. WHITCOMB: Submitted by Dr. Wilson.

MR. MORRIS: One of Dr. Wilson's samples.

THE WITNESS: Yes.

THE COURT: And corresponds, possibly not identically with, but corresponds to number 6.

MR. MORRIS: May I put it this way; and that number 6 on Plaintiffs' Exhibit 21 was likewise—

THE COURT: That is all right, just so long as I get them tied up—likewise—

MR. MORRIS: —one of Dr. Wilson's samples.

THE COURT: Yes.

THE WITNESS: Completing the reading of the wording, bottle number 1,—

THE COURT: Oh, you don't need to do all that.

THE WITNESS: —signed J. H. W.

THE COURT: Well, just let's get what they are.

THE WITNESS: My serial number 2, letter of transmittal number 2.

By THE COURT:

Q. Now, what was that?

A. Official sample gray oxide, run number 21, mill number 1, time 2.10 P. M.

Q. Well, that was the same thing?

A. Under screen—

Q. Another of Dr. Wilson's samples?

A. Another of Dr. Wilson's samples.

Q. Can you abbreviate it by saying another of Dr. Wilson's samples?

A. Do I understand, Judge, that you wish me just to state that I had so many samples from Dr. Wilson,—

Q. That is all that is necessary.

A. —or shall I describe them completely?

By MR. MORRIS:

Q. If you will tell us that you made examination of certain samples, and the number of them, which samples were taken by Dr. Wilson, and then give us the results of that examination, I will be obliged.

By THE COURT:

Q. How many?

A. I have six samples all labeled official samples, all labeled, signed J. H. W.

Q. And they all—

MR. MORRIS: —were defendant's gray oxide produce.

THE COURT: Yes.

THE WITNESS: They were all gray oxide.

THE COURT: All right.

THE WITNESS: I had in addition a sample, it was my serial number 7, serial number in the letter of transmittal number 7, for which the label was merely sample number 28.

By MR. MORRIS:

Q. And no designation?

A. There was no designation on that sample.

Q. So you made a blind examination of that without knowing where it came from?

A. Yes.

MR. MORRIS: All right, we will show that that was a Toronto sample, but Dr. Davey didn't know it.

THE COURT: Well, it was a Toronto sample, all right.

MR. MORRIS: It was a Toronto sample.

THE COURT: All right.

MR. MORRIS: I will show that by another witness.

THE WITNESS: My serial number 8, serial number 13 in the letter of transmittal, mechanical mixture—

By THE COURT:

Q. What does that mean?

A. —67.51 per cent red PbO after Cohen.

A. 51 per cent red PbO, after Cohen; 32.49 per

A. 57 per cent red PbO, after Cohen; 32.49 per cent Eimer and Amend finest powder.

Q. What does that mean?

A. That is a mechanical mixture of red lead oxide and the material which Eimer and Amend claim is lead, but which is actually again a mixture of lead and red lead oxide.

Q. In a general way would that correspond to anything on 21?

A. Not according to my memory.

Q. All right.

A. My serial number 9, letter of transmittal, serial number 8, gray oxide sample number A-2 near middle of mill.

Q. Is that from the defendant's mill?

A. Apparently not an official sample because it has no signature from Dr. Wilson.

Q. But it was from the defendant's mill?

By MR. MORRIS:

Q. It was a product from defendant's mill, as I understand it.

A. So I understand. It was labeled number A-2, near middle of mill.

THE COURT: All right.

THE WITNESS: My serial number 10, serial number in the letter of transmittal number 9, gray oxide sample number B-2 near discharge end of mill.

My serial number 11, serial number in letter of transmittal 12, Eimer and Amend lead metal, finest powder.

My serial number—

By THE COURT:

Q. Well, that would correspond with what he calls test lead on his number 2?

A. I presume it would correspond to test lead, except that it came from a different source.

Q. Yes, isn't that right, it generally corresponds with your test lead.

DR. CLARK: Yes, of course, these very fine powders usually have oxide in them.

THE COURT: Well, I mean, I am just trying to get what it corresponds to in your 21. It would be number 2 on your 21, which you have got marked test lead?

DR. CLARK: Yes, that is right.



THE COURT: All right, we have that. That is number 9.

THE WITNESS: That is sample number 11 in my serial series, I used as a material from which to get a comparison standard of metallic lead.

THE COURT: Yes.

THE WITNESS: Of the diffraction pattern of metallic lead.

THE COURT: All right, it was your test lead.

THE WITNESS: I used not only this test lead but also the value given in the International Critical Tables for the lattice parameter of pure lead.

My serial number 12, serial number in the letter of transmittal number 10, yellow PbO after Cohen.

By THE COURT:

Q. What was your number 12?

A. Yellow PbO after Cohen.

Q. Well, now, wait a minute, that corresponds to number 1, doesn't it,—

A. Presumably.

Q. —on 21?

A. Presumably, yes.

Q. All right, that is number 1.

By MR. BETTS:

Q. What is the last word?

THE COURT: Yellow PbO.

THE WITNESS: After Cohen.

THE COURT: Oh.

THE WITNESS: Cohen is the gentlemen who

made the recipe which is regarded as standard for making yellow PbO.

My serial number 13, no serial number in the letter of transmittal, red PbO after Cohen.

By THE COURT:

Q. Well, that corresponds, roughly, to number 3 which he has, tetragonal PbO, isn't that right?

A. So I understand.

Q. All right.

A. In addition I received two lead balls from Mr. C. A. Hall, of the Electric Storage Battery Company. These balls reached me in sealed tin cans in an atmosphere of nitrogen. They had been taken according to Mr. Hall's letter of transmittal from the body of the mill. They were marked "balls".

THE COURT: I hope they were cool by the time you got them. When I sampled them they were hot down to the middle.

THE WITNESS: They were put in this atmosphere of nitrogen as soon as—

(Discussion off the record.)

THE WITNESS: May I go back a little bit, to get continuity?

(Interruption.)

By MR. MORRIS:

Q. Will you proceed?

A. May I ask the stenographer to read as far as I have gone in answer to this question, the last two sentences in answer to this question, so that I may get continuity.

(The answer was repeated by the Reporter, as follows:

"These balls reached me in sealed tin cans in an atmosphere of nitrogen. They had been taken according to Mr. Hall's letter of transmittal from the body of the mill. They were marked 'balls'.")

THE WITNESS: These balls had been taken from the mill as rapidly as possible, had been put in the cans with nitrogen, and had been sealed with as little loss of time as possible. This information I have direct from Mr. C. A. Hall. These two balls became my samples 53-A and 53-B.

MR. SCHAFFER: If Your Honor please, we move that the part of the answer relating to how the balls were collected and shipped be stricken out.

MR. MORRIS: No objection.

THE COURT: Oh, yes. It is all right.

By MR. MORRIS:

Q. Will you proceed, Dr. Davey?

A. I have made the following investigations of these samples. I have investigated the Eimer and Amend lead finest powder, and find that it is composed very largely of red  $PbO$ , the remainder being metallic lead.

I have treated the  $PbO$  from Eimer and Amend finest powder with acetic acid, and the residue gives nothing but the diffraction pattern of metallic lead.

I have compared on the same film the diffraction patterns of Eimer and Amend's finest powder with the mechanical mixture of  $Pb$  and red  $PbO$ , and find that the lines are in identical positions.

May I ask whether I said on the same film?

THE REPORTER: Yes, you did.

THE WITNESS: I have compared the mechanical mixture of Pb and red PbO with each of the six official samples and find exact correspondence between the lines. I find no additional lines on the official samples of gray oxide which are not present in the diffraction pattern of the mixture of metallic lead and red PbO.

BY THE COURT:

Q. No diffraction lines at all?

A. No extra lines which are not on the mechanical mixture.

BY MR. MORRIS:

Q. Now, I don't know whether the last statement is clear. You find lines for lead and red PbO?

A. Correct.

Q. And no other lines than those representing lead and red PbO?

A. Correct.

BY THE COURT:

Q. Well, that, of course, is directly in conflict with what Dr. Clark testified that he found in the same samples.—

A. Correct.

Q. —or the corresponding samples?

A. Yes.

THE COURT: All right.

MR. MORRIS: We shall show, if Your Honor please, so that you may have in mind that we are going to show, we are going to show that by this witness, we are going to show that by Dr. Anderson—

THE COURT: Well, that is all right. I didn't

want to inquire into that, but I just wanted to be sure that that was a direct—

THE WITNESS: You are quite correct.

MR. MORRIS: I was only telling you that so you would have the trend of what our testimony is going to be.

THE COURT: All right.

THE WITNESS: There is a difference between my experimental results and the experimental results which have been submitted by the plaintiff.

THE COURT: All right.

THE WITNESS: I have examined the material which was delivered to me as my serial number 7, designated on the container as sample number 28, and I have compared on the same film—excuse me—and I have compared the diffraction pattern so obtained with the diffraction patterns of red PbO and with the data for metallic lead calculated from the standard data given in the International Critical Tables. This diffraction pattern of my serial number 7 was a precision diffraction pattern, so that it was correct to compare my written data with the data from the International, calculated from the International Critical Tables and with the data for red PbO. I find that specimen number 7 coming from the container labeled sample number 28 contains metallic lead, red PbO, and no other crystalline material.

BY THE COURT:

Q. That is the Toronto mill product?

A. Excuse me, I didn't hear you.

Q. It is the Toronto mill product?

By Mr. MORRIS:

Q. That is what you found out after you had made the analysis was the Toronto mill product?

A. After I had made the analysis and submitted my report on it, then and not until then was I told that it was the Toronto mill product.

I have examined the two lead balls submitted to me by Mr. Hall, which were my specimens 53-A and 53-B. The specimens were prepared by putting the tin cans in an atmosphere of nitrogen, opening the tin cans in an atmosphere of nitrogen, as proved by the fact that a match would not burn. Nitrogen was being pumped into this container continuously from a tank of nitrogen. The balls were opened in this oxygen-free space. The coating from the balls was scraped off, was diluted with corn starch, in the customary manner, and was loaded in the specimen tubes. The specimen tubes were sealed with Penn State wax.

The balls were returned to the tin cans. The tin cans were soldered shut again, all in an atmosphere of nitrogen, and the absence of oxygen was shown again at the end of this operation by the fact that a match would not burn. It is evident, therefore, that there was no chance for subsequent oxidation of the coating of these balls during the time that we had open the tin cans and had loaded the specimen tubes.

My X-ray examination of the coating from these two balls shows in each case the presence of metallic lead and the presence of red PbO.

In the case of specimen 53-A there were no other lines in the diffraction pattern except those corresponding to metallic lead and red PbO.

In the case of specimen 53-B there were in addition to the lines of red PbO and metallic Pb three exceedingly faint lines, which extended only part way along the width of the diffraction pattern, and I have

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called them "partials" in my report, to show that they did not extend the full length that would have been expected from a true diffracted line. I have labeled in my report the intensities of these three lines as follows: v. v. v. v. f. partials; may be imagination. In other words, I was trying very hard to be sure that I had put in everything that I could see, or anything that I could even imagine I could see. These three lines corresponded to the following interplanar spacings: 2.35, 2.20, 2.10.

I am not sure that those three lines are actually present in the film. If they are present in the film I don't know what material they correspond to. In any case, in neither the diffraction pattern of specimen 53-A nor in the diffraction pattern of specimen 53-B did I find any lines corresponding to those which have been attributed to this so-called compound,  $\text{Pb}_2\text{O}$ .

By MR. MORRIS:

Q. Have you your films showing the lines for these respective exhibits?

A. I have.

Q. Will you present them?

A. In addition to those films I have prepared certain charts for the convenience of the Court, which are easier to see than the films, and if the Court pleases I should be glad to show the Court—

THE COURT: Yes.

A. —the charts.

THE COURT: Yes, I can't read the films.

THE WITNESS: Excuse me, I didn't hear you.

THE COURT: I can't read the films. Let me have the charts. Oh, you have got them there?

(The witness produced the charts.)

THE WITNESS: These are taken directly from the films, and after they have been drawn have been checked carefully by myself with the films themselves, and an exact correspondence has been found.

In the case of the first two charts I have indicated the intensities of the lines roughly by the heights of the lines on the chart for the metallic lead and for the red  $\text{PbO}$ , that is, metallic lead from the International Critical Tables, and the red  $\text{PbO}$ . For subsequent charts I have not done that because the material seemed to be identical, and it did not look as though it would be worth while to try to indicate lines, intensities of lines which were identical on the two halves of the film.

By Mr. Morris:

Q. Now, will you present your films and tell me when you produced them and what they represent?

MR. MORRIS: Does Your Honor want to take time to examine any of these films over a reading box? I don't suppose you do.

THE COURT: I don't think so, no.

MR. MORRIS: I wouldn't think so.

THE WITNESS: This is going to take a little time.

MR. MORRIS: All right.

(Discussion off the record.)

MR. MORRIS: I offer in evidence as Defendant's Exhibit 137 a copy of the chart referred to by Dr. Davey.

(Chart prepared by Dr. Davey was marked Defendant's Exhibit number 137.)

THE WITNESS: There are in addition, I think, one or two charts on the end of that tabulation. I say, there are one or two charts on the end of that tabulation, which I have not yet taken up.

By MR. MORRIS:

Q. Are they on this, too?

A. Yes.

Q. You don't want to say anything about those now, or do they come in answer to something else?

A. They will come immediately.

MR. MORRIS: Let it stay in as part of 137, and we will deal with that later.

THE COURT: Where is the color chart of the plaintiffs'?

By MR. MORRIS:

Q. Dr. Davey, suppose we pass the film, the question of your films for a moment. Then we will conclude your examination without introducing the films. Then when you are off the stand you can introduce these films and classify them.

A. That will save a great deal of time.

Q. Dr. Davey, can you tell me how small a quantity of another lead compound you could have discovered by your X-ray methods if such additional lead compound had been present in the mixture?

A. I can.

Q. And on what grounds do you base your answer to that inquiry?

A. I wanted to find out how small a percentage of this so-called  $Pb_2O$  I could have found if any such material had been present. I had no  $Pb_2O$ . As far

as I know, no one else has ever had, and so I had to get a proxy for it. The proxy was the Electric Storage Battery Company gray oxide, which was largely red  $\text{PbO}$ . Having used red  $\text{PbO}$  as my proxy for the so-called  $\text{Pb}_2\text{O}$ , I used the yellow  $\text{PbO}$  as a proxy for all of the rest of the material in the samples. I made up mixtures with known percentages of the gray oxide in the yellow  $\text{PbO}$ , and I found that I could detect one per cent of gray oxide in yellow  $\text{PbO}$  with certainty, that I could not detect a tenth of one per cent with certainty. Somewhere between a tenth of one per cent and one per cent is, therefore, the limit of accuracy for determining the presence of a small amount of some other lead compound in the presence of the oxides of lead.

Q. Do you have some data with respect to that on your Exhibit 137, Defendant's Exhibit 137?

A. I have.

Q. Does it need interpretation by you, or is it self-explanatory?

A. I think it is self-explanatory. In my chart 13 I show the diffraction patterns of red  $\text{PbO}$ , the one per cent mixture of gray oxide with ninety-nine per cent yellow  $\text{PbO}$ , and yellow  $\text{PbO}$  alone.

(Discussion off the record.)

THE WITNESS: Will you please read my answer?

(The answer was repeated by the Reporter, as follows:

"In my chart 13 I show the diffraction patterns of red  $\text{PbO}$ , the one per cent mixture of gray oxide with ninety-nine per cent yellow  $\text{PbO}$ , and yellow  $\text{PbO}$  alone.")

THE WITNESS: Yes, I have read  $PbO$  alone, yellow  $PbO$  alone, both for purposes of identifying the positions of the lines which belong to them. I have the mixture of one per cent gray oxide and ninety-nine per cent yellow oxide, and the presence of the gray oxide is quite evident in the diffraction pattern of that test sample.

I have similar tests for higher percentage, namely, five per cent gray oxide mixed with ninety-five per cent yellow oxide.

Would the Court like to examine the charts for these, to show—

THE COURT: I am going to get their set of charts.

THE WITNESS: That completes the series of charts which I have made.

By MR. MORRIS:

Q. Does that conclude your answer to the question, Dr. Davey?

A. It does. I could have determined as much as one per cent of an extra lead compound in the gray oxide, if it had been present.

Q. Now, then, am I right in this summary, that you did examine defendant's product, —

A. I did.

Q. —and you found no lines on your films in any way corresponding to the alleged  $Pb_2O$  lines? Am I right, or not?

A. That is correct.

Q. Is the same thing true with respect to what you subsequently discovered was the Toronto product?

A. That is correct.

Q. And your last statement, as I understand it, is that if there had been a lead compound, other than

the ones that you have mentioned, in any of your products, at least in a quantity equal to one per cent, your tests showed that lines therefor should have appeared on your films, or not?

A. That is correct.

MR. MORRIS: Direct-examination closed.

*Cross-examination.*

(Discussion off the record.)

By MR. WHITCOMB:

Q. Which type of X-ray apparatus do you regard as more accurate, using the type that Dr. Clark used, or yours, on the target material?

A. An answer to that question, must imply a knowledge of what the apparatus is to be used for.

Q. Well, for the purpose of this case.

A. I can illustrate that by saying a horse is more useful in some cases—

Q. I say for the purpose of this case.

A. —and a cow in other uses.

Q. Of course, I am not asking about some other case.

A. For the purpose of this investigation an ideal situation would be obtained—

Q. Well, I am asking which—

A. —by using both.

Q. —which is most advantageous; are they the same?

MR. MORRIS: He has answered it. He said both.

THE COURT: Well, that really is not an answer. He asked which one is the more accurate—

MR. WHITCOMB: Accurate.

THE COURT: —and more advantageous for this thing.

MR. MORRIS: But may I call Your Honor's attention to this? Dr. Davey has used a molybdenum one. We are going to show by Dr. Anderson that he used a copper one. I wonder if the light of that which I promised to bring out whether his answer to that is not a perfect answer.

THE COURT: I don't think so, Judge. I think he can say whether this one is better than the other for the purpose of this case. If he doesn't think there is any difference he can say so.

THE WITNESS: For the investigation of larger interplanar spacings the copper characteristic rays are better. For the investigation of a very small interplanar spacings the molybdenum target X-rays are better.

By THE COURT:

Q. Well, which is your investigation directed to? Are these large or small interplanar spacings in the PbO?

A. I have put all on there that I have been able to find from the diffraction pattern and read with certainty.

Q. Yes, but do you call them large or small?

A. Some of them are large and some of them are small.

Q. And the interplanar spacing, does that have reference to the distances between these lines,—

A. No.

Q. —or is it something else?

A. Interplanar spacings are distances in the crystals calculated from Bragg's Law, which includes



the wave length of the X-rays, the radius of the curved photographic film, and the distance from the reference line to the line of the diffraction pattern. In my charts the left-hand line of the whole chart is the reference line.

Q. Well, all right, all I want to know, all I can get out of that is that the distances between these lines on your charts have nothing to do with interplanar spacing.

A. Not the distances between lines,—

Q. No.

A. —but the distance from here, from the most left-hand line to each of the lines.

Q. Yes.

A. That total distance for any one line is calculated back to show the distance between planes of atoms in that crystal.

• By Mr. MORRIS:

Q. Can you make a short statement, one sentence, of your theta angle by reference to the reflection of light, or does that take two minutes? If it does, don't do it.

THE COURT: Oh, I can read it in a book, I guess, if I have to.

THE WITNESS: It will take longer than one minute, yes.

MR. MORRIS: All right.

By Mr. WHITCOMB:

Q. Will you please produce the data and work sheets you used in transforming the film material to this chart you produced, Defendant's Exhibit 137?

A. I have somewhere four laboratory notebooks, not loose sheets, but bound notebooks. I thought that

I had them with me in this case. I am very sorry, I thought I had my laboratory notebooks with me; they are down in the hotel, apparently.

Q. Well, you will get them and produce them?

A. Certainly.

Q. Now, I understand—

A. I can give you substantially the same data, though, from my written reports.

By THE COURT:

Q. Now, before you do that will you tell me why, Doctor, it is what you told me before, but I think you might as well have it on the record, why Dr. Clark's photograph of the film for Pb, which is under number 2 on his Exhibit 21, shows, as I count it, about twenty-three or twenty-four plainly visible lines, and your chart for Pb shows only nine?

A. The different is due to the total exposure on the film. If I had exposed my film a longer time I could have shown still more lines.

Q. Well, are all his lines—

A. I contented myself with showing enough lines to identify the material.

By MR. WHITCOMB:

Q. Then you have not exposed your films long enough, is that right?

A. I have exposed my films long enough to get a sufficient diffraction pattern for identifying the material.

Q. But if there was anything else in there you didn't find that out?

A. Further exposure would have made very little difference in this case, because the intensity of the diffracted beams decreases as the angle of diffraction is increased.

Q. Did you try it?

A. What do you mean?

Q. Have you ever tried to make a longer exposure?

A. Certainly.

Q. When? In connection with this case?

A. In connection with this case.

Q. Yes, when?

A. It is a matter of ordinary experience.

Q. Well, when did you do it?

A. Tried to take a longer exposure?

Q. Yes.

A. I have taken exposures so long that it was—that it gave a fogging, a general fogging of the film.

Q. Will you produce your records and data sheets that you used in connection with that?

A. I can. I have already told you that my laboratory notebooks unfortunately have—

Q. Oh, they are in the same notebook?

A. Certainly, and I have the films which show it, which have been promised to be introduced in evidence, as soon as I get time to sort them out.

Q. Now, as I understand it, your powder was placed in glass tubes, is that right?

A. Correct.

Q. And you heard Dr. Clark testify that his was not placed in a tube, is that right?

A. I did.

Q. In your opinion what effect would the tube have,—

A. The tube tends to increase—

Q. —in contradistinction to the other?

A. The tube tends to increase the general fog somewhat,—

Q. So your film—

A. —and the material—wait a minute.

Q. — could not be as clear as the other?

A. Wait until I finish—and the tube tends to cut down the intensities of the lines, especially those of higher interplanar spacings.

The wedge technique I suppose is subject to the exact materials used in forming the wedge. I have no knowledge of what kind of a mould the wedge was made in, so that I cannot tell whether there was any contamination from the wedge, or not.

Q. Assume that it was just placed in the little cradle that held the wedge, without any mould.

A. No, I mean in making the wedge itself, in the first place, I don't know what moulding material he used, so that I can't tell whether there was any contamination likely from that or not.

Q. Is it necessary to use any moulding material?

A. You can't make a wedge without pressing something together, can you?

Q. In this case my information is that it was done without any moulding material whatever.

A. Do you mean to say he took a powder and made a wedge out of it without pressing it against anything?

Q. He didn't use any moulding material in the wedge.

A. That is not what I am talking about. I am saying any material used as a mould.

Q. How long did you expose your samples to the action of the X-ray.

A. Anywhere from eighteen hours up to about three days.

Q. You understood that Dr. Clark testified that his were an average of about an hour, I believe, is that right?

A. Yes, with some going up to three hours.

Q. Do you think the longer exposure would have

any different effect in your tests, as compared to those in which a short test is made?

A. If so, such effect is not now known.

Q. Well, if there were  $Pb_2O$ , or a suboxide, whether you call it strictly  $Pb_2O$ , and it does have this fugitive characteristic, were you to take eighteen hours to make a test would it not be possible to change from one composition to another during that time?

A. I suppose we have about the same chance of getting a change that we have in the official sample introduced by the plaintiff in that test tube, which has certainly been—

Q. Well, there is a chance?

A. —more than eighteen hours in the test tube, with just a couple of corks to keep the air out.

Q. Well, then, there is a decided chance of change, is that right?

A. I said about the same chance as that sample, which has been submitted as evidence of being pure  $Pb_2O$ .

Q. Well, did that have a decided chance of change?

A. That I can't tell, because I don't know that it is  $Pb_2O$ . If it is  $Pb_2O$  I don't know the properties of  $Pb_2O$ , except from hearsay—

Q. Well, making the assumptions—

A. —for what it is supposed to be for the supposititious compound.

Q. Making the assumptions I just made when I started this line of cross-examination, what have you to say on that? In other words, you think that Dr. Clark's sample might have changed as he brought it from Illinois here?

A. If it is as fugitive a substance as he has claimed, and as Ferrari has claimed, I suppose the burden of proof is on him that it did not change.

Q. Well, I am asking you what you thought,—

A. I haven't qualified—

Q. —your opinion?

A. —as an expert on  $Pb_2O$ . I have never seen any.

MR. WHITCOMB: Your Honor, I mean, you see, we are making certain assumptions.

THE COURT: Well, what you want to know, as I understand it, is whether there was a—I don't know, but—

MR. WHITCOMB: I asked him if he thought there would be a change during the time of taking his exhibits.

THE COURT: Yes, he hasn't answered that question.

MR. WHITCOMB: He hasn't answered.

THE COURT: That is really the question we got off on.

By THE COURT:

Q. Do you or do you not think that oxidation took place during the taking of the pictures in your experiments?

A. I do not think any oxidation took place during taking of pictures in my experiments with the official samples. I am sure that it could not have taken place with my samples—

Q. With the lead balls?

A. —with the lead balls—what were they, 83-A and B?

Q. 53-A.

A. 53-A and B.

THE COURT: That is what you wanted to ask, Mr. Whitcomb?

THE WITNESS: Because there was no oxygen present by which—no free oxygen present by which they could be oxidized.

As for the general case I can't say, because the only interpretation I can make of your question is, if it is an unstable compound would it be likely to be decomposed? The answer is obvious; if it is an unstable compound it would be likely to be decomposed.

By THE COURT:

Q. What happens to your X-ray film if you are examining an unstable compound that decomposes during the period of exposure? What sort of a film do you get?

MR. WHITCOMB: Where it is eighteen hours.

THE COURT: Yes, I am not referring particularly to lead, because I realize that you do not agree that there is any  $\text{Pb}_2\text{O}$ , but take an unstable compound. I suppose there are other unstable compounds—

THE WITNESS: I can illustrate—

THE COURT: —that will decompose in air.

By THE COURT:

Q. Now, suppose you expose them to your X-rays, and while that is going on they change their character; what happens to your film?

A. I can illustrate that in terms of some experiments that I made many year's ago, on the halides of silver. Silver chloride is decomposed supposedly—

Q. Well, that might take too long.

A. —by either light or X-rays,—

Q. That might take too long.

A. —and then I was able to—



Q. Can you tell me briefly—

A. —get a diffraction pattern of the silver chloride—

Q. What?

A. I was able to get a diffraction pattern of the silver chloride with the molybdenum rays.

Q. That was the original thing?

A. I was able to get a diffraction pattern of silver chloride itself, in spite of the fact it is supposed to decompose slowly under the action of the X-rays.

THE COURT: All right.

By MR. WHITCOMB:

Q. When you placed your samples in the tube was there any water formed?

A. Will you please read that again?

Q. You, as I understand it, you took some of this powder and put it in a tube to make your X-ray examination, is that right?

A. Yes.

Q. Now, is there any formation of any water during that procedure?

A. No, there wasn't—I suppose you mean was there any visible water present; there certainly was not, or we could never have loaded the tubes.

Q. Did you seal the glass?

A. The glass was sealed with wax. In the case of the specimens 53-A and 53-B the glass was sealed with a very special wax, which we call Penn State wax.

Q. But as to the others, you did not seal them under nitrogen, and you had the contact with the ordinary room atmosphere, did you not?

A. Yes, they were sealed—

Q. Any moisture in the air would—

A. They were loaded in air and sealed in air.

Q. And any moisture in the air would have been trapped in the tube, is that right?

A. Any moisture would have been trapped in the tube as moisture, not as liquid water, with the same proportions—

Q. Was it  $H_2O$ ?

A. —that would exist in the room at the time.

Q. Was it  $H_2O$ , whether it is moisture or water, are you trying to make a distinction?

A. Within the meaning of your question I should say, yes.

Q. Was the background of your films clear enough to see faint lines?

A. Yes.

Q. Was it as clear as it would have been if you had not had to use the glass tube, and had not had to have it exposed as long as you had to have it exposed?

A. Theoretically, no.

Q. Did you make any microphotometer examinations such as—

A. No, ordinarily they are not very useful.

Q. Have you any machine for making them?

A. We have.

Q. And why do you regard—

A. I have never been able to find anything with a microphotometer which contributed more real information than I could get by visual inspection of the film. It is a matter of common knowledge that the absolute intensity of a line on a photographic film of a diffraction pattern means very little; it is only the relative intensities which count, and the relative intensities can usually be determined with sufficient precision by visual inspection.

Q. How about the actual position of the weak lines, for example? Doesn't the microphotometer bring that out?

A. With interplanar spacings of approximately 100 or less I have no trouble by visual examination in locating the interplanar spacings within one part in a thousand.

Q. But I am asking you whether or not the microphotometer will bring them out clearly.

A. They will bring them out visually, but they are visual on the film, at any rate.

Q. Well, are there any lines that might have been faint and not visible that would have been brought out by the microphotometer? Is your testimony that the microphotometer would not bring out any lines that were otherwise faint and difficult of visual inspection?

A. My answer to that, I suppose, would have to be that we are all human, and that any human being is likely to fall into error, but by visual inspection I can determine, as I have already testified, the presence of an additional lead compound of concentration down as low as one per cent.

Q. Yes, but, now, will you answer the question?

MR. WHITCOMB: Please read the question.

(The question was repeated by the reporter, as follows:

"Q. Well, are there any lines that might have been faint and not visible that would have been brought out by the microphotometer? Is your testimony that the microphotometer would not bring out any lines that were otherwise faint and difficult of visual inspection?")

A. The microphotometer will bring out anything that is on the film, including fly specks and scratches.

By MR. WHITCOMB:

Q. And, therefore, is it a more accurate method than mere visual inspection?

A. Possibly a more accurate method for photometry of fly specks and scratches, but not of determining diffraction patterns.

Q. Then in your examination reliance upon visual inspection alone is the only thing you used to detect the absence or presence of faint lines?

A. Yes, sir.

Q. Did you use anything to magnify the lines?

A. I did.

Q. What?

A. A lens.

Q. What degree of magnification?

A. It was an ordinary reading glass.

Q. How many samples have you examined for this case?

A. I don't remember exactly; I should say over a hundred. I assume that your question means total number of samples, irrespective of whether they were official samples, or what?

Q. Yes, just some idea.

A. Somewhere in the general neighborhood of a hundred.

Q. Will you produce the work sheets for your work on that?

A. I can.

Q. They are in the same books?

A. They are in the same notebooks of which I have spoken.

Q. Do those books contain all the work sheets and data sheets that you have—

A. Correct.

Q. —relating to the case?

A. Yes, sir.

Q. Please explain whether or not in connection

with those ball samples you mentioned you attempted to examine it layer by layer.

A. We did not.

Q. Dr. Clark's films are about how long?

A. On a guess, I should say about six inches long.

Q. Have you got a slide-rule there?

(A film was shown to the witness.)

A. No, I do not, I have no kind of rule. Now, when you asked for the length of his film do you mean the total length of the photographic material supplied by the Eastman Kodak Company, or do you mean the length of film which is used in making a diffraction pattern?

By MR. WHITCOMB:

Q. The length of film used in the diffraction pattern.

(A rule was handed to the witness.)

A. Conditions of illumination are not at all ideal here, but I should say that he had five and one-half inches of useful film.

By MR. WHITCOMB:

Q. And how long is the slide-rule on which you made the tests that you put photographs of in evidence yesterday?

A. Twenty inches, of which about ten inches was useful.

Q. Well; then, in attempting to make those checks that you made any possible variations from the pattern were magnified in that ratio, —

A. The reason—

Q.—is that right?

A. —for using the long slide-rule was because it was impossible with an ordinary, soft lead pencil to mark the lines on the slide-rule with the precision with which the lines appeared to be on the film.

Q. But, nevertheless—

THE COURT: Well, but, now, he asked you a pretty simple question.

THE WITNESS: Excuse me, Judge. I thought I was answering it.

THE COURT: Will you read it to him, Mr. Rodebaugh?

THE WITNESS: I thought I was answering. Will you repeat the question?

THE COURT: No, I don't think you were, because the question could be answered by one word. Just read the question.

THE WITNESS: I am sorry, I have misunderstood the question, then.

THE COURT: All right.

THE WITNESS: Will you please read the question to me?

THE COURT: The question is whether—well, read it to him.

(The question was repeated by the reporter, as follows:

“Q. Well, then, in attempting to make those checks that you made any possible variations from the pattern were magnified in that ratio, is that right?”)

THE COURT: That is, of five to ten.

THE WITNESS: Now, in order to answer that question I must—I must find out what Mr. Whitcomb has in mind. Does he have in mind the magnification assuming that the marks on the

slide-rule were geometrical lines, or does he have in mind the over-all accuracy of the comparison, taking into account the width of the pencil marks on the slide-rule?

By MR. WHITCOMB:

Q. Well, when you measure an original film do you measure it to a geometrically perfect line, or don't you have to make a visual estimate of the best point to take the measurement?

A. I make a visual estimate of the correct point to take.

Q. So there is a human error there, as well as in connection with making the pencil mark.

A. But in making a pencil mark on the slide-rule, using an ordinary Eversharp pencil, it is very difficult to get the line placed to much better than a half of the division between spacings on the slide-rule. The width of the pencil mark is just about as wide as the spacing between two adjacent marks on the twenty-inch slide-rule.

Q. But regardless of that, the ratio of the length of the film, of about five inches to ten inches on the slide-rule, had the effect of multiplying by two any possible variations from the fixed pattern, isn't that correct?

A. It would have multiplied the variations by two if I could have marked my pencil marks with infinitely narrow markings, but with the width of pencil mark which I had, the uncertainty of the pencil mark was brought on that twenty-inch slide-rule to about the uncertainty of the measurements of the diffraction pattern.

You see, we must determine in all of these cases not absolute accuracy, but percentage accuracy, and the width of the pencil mark made my percentage ac-



curacy as I estimate it on the twenty-inch slide-rule about the same as the percentage accuracy in Professor Clark's data.

Q. Well, what did you mean when you say that his measurements for the metallic lead were within a quarter of a per cent accurate? You checked those with a pencil, did you not?

A. Yes.

Q. Well, what is your measurement, quarter of a per cent accurate? That is not inaccurate by more than one-quarter of one per cent, as I understood your testimony?

A. I mean that the pencil mark would not have to have been moved to a new reading differing by more than a quarter of a per cent from the actual reading to have made an exact match of the theoretical lines. That is work of considerable merit.

Q. Well, but couldn't—

A. I congratulate Dr. Clark on having such good diffraction patterns of metallic lead.

Q. But couldn't a point be, say, an inch out of the way, or a line, and then if you moved it the width of the pencil is that still only a quarter of one per cent error?

A. Now, if I understand your question correctly, you have asked me whether it would be possible on that slide-rule to have moved a line an inch and got it—got the error only a quarter of a per cent?

Q. So far as your measurement—

A. Certainly not. An inch on the slide-rule represents much more than a quarter of a per cent in the region which I specified for the measurement of percentage accuracy.

Q. How much error does an inch represent?

A. What say?

Q. How much error does an inch represent?

A. I should have to get a slide-rule to tell you, but I assume it would represent—

Q. Well, get one—

A. —an error—

Q. Get one and tell me.

A. An error of probably twenty per cent—excuse me, don't take that answer down, I will take a slide-rule and I will find out.

Q. In other words, we are trying to get at your measure of the scale of the inaccuracy or accuracy. I would be glad to have you state the basis of your determination of such percentages. Will you do so?

THE COURT: Well, I think we will recess for ten minutes while he is working on that.

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(Recess at 11:25 o'clock A. M.)

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WHEELER P. DAVEY, recalled.

*Cross-examination (Continued).*

By MR. WHITCOMB:

Q. Were you able to give us the basis—

THE COURT: Did you find that chart for me?

MR. WHITCOMB: No, sir.

THE COURT: I want that one. I don't remember having it over there.

(Discussion off the record.)

THE COURT: Well, all right. There is no use wasting time on it. You could make another one for me, I suppose.

By MR. WHITCOMB:

Q. Were you able to give us the basis of your percentage of variation that we were talking about?

A. You asked—

Q. The basis of your percentage of variation—the estimated percentages.

A. The basis?

Q. Yes.,

A. I have not made the estimate. I have—

Q. Go ahead. You made the estimate of one-fourth of one per cent.

A. The last thing was about an inch.

Q. All right.

A. In the region of the slide-rule for which I made the estimate of a quarter of a per cent error in Dr. Clark's work, thereby showing the extreme accuracy of his diffraction pattern of lead.

In that same region, the displacement of a line by an amount of one inch would have made an error of twelve and a half per cent, or over fifty times the experimental error in Dr. Clark's diffraction patterns for lead.

Q. How small an amount of substance could you determine by your method of X-ray analysis?

A. I have already testified that for lead compounds in the presence of other lead compounds I could detect one per cent.

Q. If a colloidal substance is present—an extremely finely divided substance—could you find it in this percentage that you said was your limit or the limits of your ability to detect a substance, if it was, say, one per cent?

A. The answer will depend on what you mean by finely divided substance. Of course, it is possible to have a substance, even a crystalline substance, so

finely divided that the Bragg's law for diffraction begins to fall down, and for such a material the lines get to be very diffused, and if they are very weak to begin with and then that weak intensity is spread out over a greater area over the film it becomes much harder to see.

Q. And you would not be able to detect it by your method, is that what you mean?

A. I mean that if you had a material of sub-colloidal dimensions it would be very difficult to detect it in any reasonable percentage.

Q. Referring to Plaintiff's Exhibit 21—you have one there—how would you measure the line sub ten for pattern number 10, or, rather, which is the third from the left-hand side?

A. Counting that by means of the dots—dots, do you mean?

Q. No, I mean, how would you measure the line from the center in making measurements, when you consider the pattern number ten on this exhibit ten?

A. I am still inquiring the meaning of your question, Mr. Whitcomb. Do you mean the third line as represented by the third light dot at the bottom of the line, or do you mean the third thing I could imagine was a line, or what?

Q. I mean leaving out the dots and looking at it—here (indicating), you see? It seems to be the first line, the first strong line; the next one is rather weak or the next one is rather broad. Where would you undertake to measure that third line?

A. It is very difficult to answer in terms of a print because we always work on photographic film. If I had the photographic film, I could give a much more intelligible answer.

MR. WHITCOMB: Will you get the film?

MR. SCHAFFER: Yes.

(Discussion off the record.)

By MR. WHITCOMB:

Q. Change that question to the fourth line from the left-hand side. Here's the film for pattern ten on Exhibit 21 (tendering).

A. Are we going to speak of the same line? Now, I see here one line—do you see that?

Q. No.

A. It's at the corner there (indicating).

Q. Let me pick it out on this.

A. Suppose you put a mark on the film.

Q. I can't do it on the film, but here it is on there.

THE COURT: I will have to ask you to suspend here for a minute.

(Discussion off the record.)

THE WITNESS: I have your film number 94-B, suboxide.

By MR. WHITCOMB:

Q. Exhibit 28-A.

A. I am told now that the line about which I am asked is no longer the fourth line. It is actually the eleventh line.

Q. No, sir; I beg your pardon.

A. Yes, it is; and it is marked with a dash in ink, and I am so informed by Dr. Clark himself that that line there is not the fourth, but it is very evidence it is the eleventh.

THE COURT: Do you agree to that, Doctor?

DR. CLARK: All right.

THE COURT: All right, call it the eleventh. It's the one marked with a dash.

THE WITNESS: It is the only one on the film marked with a dash.

MR. WHITCOMB: All right.

THE WITNESS: With a wide line like that, it is my custom to make a reading at each edge of the line, thereby indicating the total width of the line and indicating the peak of the line limits, somewhere in these two limits.

By MR. WHITCOMB:

Q. In that case, it is micrometer—

A. No. And it gives an average blackness over the long length of the slip through which the light travels, if there should be an especially dark spot, which I have indicated by means of a fly speck, although I don't intend to limit myself to a fly speck. If there should be a small black spot somewhere on that film, the micrometer will register exactly the same as if it is a weak line extending all over the whole range of the micrometer slip.

Q. You measure both sides?

A. Yes, I measure both sides of the bands—the sides of the bands.

Q. Then, for that particular line, it would be accurate to scale if it was anywhere between those two?

A. No.

Q. Why not?

A. Because a single reading on a band does not represent the fact that it is a band and does not represent—it does not represent anything by which we can interpret the band.

Q. But, if I took a certain measurement and said that that was the line, and it came between that band,

would you swear positively that that wasn't the line for that particular diffraction and accurately represented that particular diffraction?

A. Well, if you gave me a reading to three decimal places of this line or to two decimal places of this line, without my having seen the film, I would assume that you had measured to within the precision indicated by three decimal places or two decimal places.

Q. I am not talking about reading; I am talking about plotting a line and having drawn the line.

A. I am assuming that you are referring to my plotting the lines on the slide-rule?

Q. Something like that.

A. I plotted the data which had been submitted in evidence—

Q. I am asking you—

A. —and I had no photographic film by which to check the data. I took the data as they were offered in evidence.

Q. I know, but we want to get along with the case. Now, I am asking you if I took a line from there, or if you take a line—I will ask you to take a line, and if you don't take it in either the beginning or at the end of that band, but you specify it in between. That still represents the diffraction for that particular substance from that X-ray, does it not?

A. If I were plotting a band of this sort on a slide-rule, I would plot the two limits of the band and come between the two lines—connect between the two lines of the slide-rule, to show that it was on the band. That is my standard practice.

Q. Is it possible, in your opinion as a scientist, to take measurements from the film which would produce lines which were actually—which would actually fall within the face-centered cubic pattern from any of these films?



A. I have already shown by the slide-rule method that it was possible to find from Dr. Clark's measurements submitted in evidence a diffraction pattern for lead which did match the face-centered cubic pattern within one-quarter of a per cent, which I regard as a very high degree of accuracy in individual lines, and—

Q. Now, is it possible—

A. —he is to be complimented on his work.

Q. —for the measurements, bearing in mind this testimony that you have just given about a broad band, or to make lines from these films which would produce a cuprite structure or the latticework shown by Dr. Clark in his Exhibit No. 29, which he has labeled  $Pb_2O$ ?

A. It is impossible to answer such a question without actually making measurements on the photomicrometer film and planning out what the limits would be. What I plotted and offered in evidence is the actual data submitted by the plaintiff. There was nothing on the data sheet to indicate whether it was a band or a line. I just took—I took just whatever the plaintiff submitted as evidence.

Q. We have submitted the films as evidence. Why didn't you refer to the film?

A. I referred to the data sheet. Why should I take the time of the Court and hold up all the proceedings—

Q. Because it will probably help the plaintiff, that's why.

A. —for weeks to get the data when the data sheet was already submitted.

Q. Please refer to your Exhibit D-137. Have you got it?

A. No. I don't even know what it is.

Q. Well, that's a copy (tendering), or do you

want the original? No, you have the original right in front of you.

A. I assume this is what you are talking about.

Q. Is this the original?

(Discussion off the record.)

By MR. WHITCOMB:

Q. Please refer to page two of this exhibit—the lines that I have marked in red—and state why that appears to be, or does not match?

A. The chart to which my attention is referred has to do with the comparison of the diffraction patterns or a mixed—or a mixture of—a mechanical mixture of lead and red PbO, with a diffraction pattern of Eimer and Amend lead, finest powder.

By THE COURT:

Q. That's chart number two?

A. It is chart number two.

Q. The first one up there?

A. Yes.

(Discussion off the record.)

THE WITNESS: I have been asked to explain why the next to the last line in the upper row of lines of that chart does not match the next to the last line of the lower row. Each of those lines was probably present in the diffraction patterns, but it sometimes happens that the orientation of a particular crystal plane is missing in a powder, so that it is—excuse me, just withdraw that answer, and I will start again.

By MR. WHITCOMB:

Q. Well, I think it—all right.

A. It sometimes happens that there are not as

many samples of a particular orientation in the powder specimen for one specimen as there may be for another powder specimen, and so it will turn out that sometimes you will get a line and other times you may not get that same line for a diffraction pattern. Now, I am not speaking here on anything except an individual line in a sequence of lines. Now, it can be shown by comparing this chart with other charts that the next to the last line in the upper row of lines matches the diffraction pattern previously found for a mechanical mixture of red PbO and metallic lead.

Q. Where can you show that?

A. If you will let me take that chart which you just borrowed, on the tracing cloth.

Q. Here it is. Well, isn't this a duplicate of what you have in your hand?

A. This is a duplicate of that, yes, but I want to show you the transferences. Now, you will notice—let me see, I will get that this way—that, on that upper row of lines, one is a red PbO line. Are you satisfied as to that?

Q. Well, you go ahead and give your complete answer.

A. All right, let me give a complete answer. (Exhibiting.) I am matching the Chart No. 1, Specimen No. 13, Film 5, with Chart No. 2, Specimen No. 8, Film 3-A, and find that the next to the last line on the upper row—excuse me, this is off the record. Did I say Chart No. 2, Specimen 8, or did I say Specimen No. 11?

(The Reporter then repeated the following:

“A. . . . I am matching the Chart No. 1, Specimen No. 13, Film 5, with Chart No. 2, Specimen No. 8, Film 3-A. . . .”)

THE WITNESS: Now, then, if you will please read the rest of it so I can get the continuity.

(The Reporter then repeated the following:

"A. . . . and find that the next to the last line on the upper row—")

THE WITNESS: —on the upper row corresponds to the line or to a line in the diffraction pattern of red lead.

I am now comparing Chart No. 1, diffraction pattern of metallic lead from the International Critical Tables, with Chart No. 2, Specimen 11, Film 3-A, and find that the next to the last line matches a line from the diffraction pattern of metallic lead.

I have already testified that the Eimer and Amend lead, finest powder, represented on the lower set of lines of Chart 2 shows the presence of both Red PbO and of metallic lead.

I have already testified that the upper row of lines represents the mechanical mixture of metallic lead and red PbO.

One of those displaced lines belongs to the lead pattern; the other belongs to the PbO pattern; and, therefore, it is not to be expected that those two lines will necessarily register.

In answer to your question, I could say that one of the lines from red PbO is missing on one of the series of lines of Chart 2 and that one of the lines of metallic lead is missing from the other.

By MR. WHITCOMB:

Q. Well, please refer to page four of your charts, Chart 8, and explain the difference between the group of two lines, third end from the right-hand side. Can you see it there (indicating)?

A. I see it, yes.

Q. All right.

A. One of my reports seems to be missing, from which I wish to go back to the original data to discover the details of that, of those lines. I had that report here just a few minutes ago.

Q. In this case, there is a discrepancy that you want to explain. Is that right?

(Discussion off the record.)

By MR. WHITCOMB:

Q. Before you refer to your notes, will you answer the last question?

A. Will you please give me the last one?

MR. WHITCOMB: The stenographer will please read it.

(The question referred to was then repeated by the Reporter, as follows:

“Q. In this case, there is a discrepancy that you want to explain. Is that right?”)

By MR. WHITCOMB:

Q. Dr. Davey, will you answer that one?

A. I wish to refer to my notes and refresh my memory in order that I may answer your previous question correctly.

Q. Well, that still does not answer my question. Is there or is there not a discrepancy that you want to explain?

A. There is a displacement of the lines. Is that what you mean by discrepancy?

Q. The lines do not match?

A. If that's the interpretation of your question, the answer is yes.

Q. Then, will you proceed to do so?

A. I find from my report that the tenth line in

both rows of Chart 8, taken from Film 16, represents a line so faint as to be barely on the limits of visibility. I have labeled the intensity of this line very, very, very faint—in code, v. v. v. f. That's my code for a line whose intensity is so small that it is barely possible to see it and still be sure that it is actually there.

The order of accuracy of the reading of such very faint lines is low. I have recorded the positions of those lines, but I am not at all sure that those recorded positions are correct because the intensity is so low. They represent my best judgment in reading the film for those two individual lines.

Q. What about the eleventh line from the left-hand side?

A. It is the eleventh line that I thought I was talking about. Didn't I say the eleventh?

Q. I thought you said the tenth.

A. Excuse me. If I said tenth, I meant the eleventh. The tenth line is obviously registered on the chart in spite of the low limit of accuracy of the reading.

Q. Now, refer to page three of your Exhibit 137, chart—two charts—and state whether or not the last line in the lower one, No. 5, matches with the one above, No. 7?

A. It does not, quite.

Q. Why is that?

A. It was the last line which I was able to read with anything like certainty on the photographic film. The further toward, to the right, you go—to the right in the photographic film you go in your readings in general, the fainter the lines get to be. This was the last one I was able to read with certainty. The order of accuracy of reading those lines, except under the most favorable conditions, is not as high as for the other lines.

I should like to call your attention, however, to the fact that there is a systematic match between the lines of the upper and lower row on that same chart. Except for that last line—that's one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen—thirteen lines show a match.

Q. Are you acquainted with Le Blanc's work?

A. Somewhat.

Q. I hand you a pamphlet and call your attention to Figure 5 on 137, and ask you to state whether or not those two patterns there match?

A. My answer will have to be qualified by the assumption, or by an assumption, as to the precision of readings represented by the lines on this Figure 5, about which my opinion has been asked. If these two diffraction patterns represent precision readings, taken with the proper calibration material in the customary way, then the match is not too good. If they do not represent precision readings, there is no possible way of deciding whether the match comes within the limits of precision of the data or not, without going back to his original note book records.

Q. Well, aren't you justified from the data there, that is given there, justified in concluding that those two materials are identical—assuming the degree of accuracy that any scientist would use in publishing a pamphlet, bearing also in mind the reputation of the writer?

A. I assume that the author intends to convey that, within the precision of his experiments, he gets a substantial match between his diffraction pattern for red  $\text{PbO}$  and his diffraction pattern for the so-called  $\text{Pb}_2\text{O}$ .

Q. And yet the lines do not match within the meaning of your general testimony about the matching of lines. Is that right?



A. In that case, "his" means the author of this article in which the figure occurs that has been brought to my attention.

Q. Will you answer my question?

A. Give me the question again, please.

(The question was then repeated by the Reporter, as follows:

"Q. And yet the lines do not match within the meaning of your general testimony about the matching of lines. Is that right?")

THE WITNESS: They don't match within the precision of the measurements which I have tried to show on our charts.

By MR. WHITCOMB:

Q. Now, refer to another figure in this pamphlet.

THE COURT: Let me see that a minute, please.

(Discussion off the record.)

MR. WHITCOMB: Although these do not match, the pamphlet says they are the same thing, showing what an outsider does and how near they may come.

THE COURT: What is the effect of this?

MR. WHITCOMB: We will show that some of those patterns of Dr. Clark's that do not match—that will justify the conclusions of Dr. Clark.

THE COURT: Oh, you are not talking about his?

MR. WHITCOMB: No.

By MR. WHITCOMB:

Q: Well, have you ever decomposed lead oxalate and made patterns? Have you proceeded in that method?

A. I have decomposed lead oxalate, yes.

Q. And have you got the data for your patterns made from the results?

A. I think I have that.

Q. Are they in these notes?

A. If that is reports copied from those notes, yes.

Q. I have here a sheet with the spacings for the calculated theoretical results by Dr. Clark, using the a sub zero value of 5.33, and another one calculated from Ferrari, using the value of a sub zero of 5.38, and also a corresponding list of those found from Dr. Clark's charts submitted in evidence, and I would like to have you check these over and see if they are correct?

A. All right.

(Discussion off the record.)

THE COURT: Well, I think we might as well adjourn at this point.

MR. WHITCOMB: We would like to have this marked, for identification, as the Plaintiffs' Exhibit No. 62.

(Sheet showing the comparative numerical values calculated and found for a cuprite structure was then marked as Plaintiffs' Exhibit No. 62.)

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(Recess, 12:30 to 2:00 P. M.)

AFTER RECESS.

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Present:

Counsel as before noted.

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WHEELER P. DAVEY, recalled.

*Cross-examination (Continued).*

MR. MORRIS: If Your Honor, please, I offer in evidence as Defendant's Exhibit 139 Dr. Davey's notebook number 1,—

THE COURT: All right.

MR. MORRIS: —as Exhibit 139, Dr. Davey's notebook 4, which is a continuation of notebook 1; as 140 Dr. Davey's notebook 2; and as 141 Dr. Davey's notebook 3, which is a continuation of 2.

(Notebook of Dr. W. P. Davey, number 1 was marked Defendant's Exhibit number 138.

Notebook of Dr. W. P. Davey, number 4 was marked Defendant's Exhibit number 139.

Notebook of Dr. W. P. Davey, number 2 was marked Defendant's Exhibit number 140.

Notebook of Dr. W. P. Davey, number 3 was marked Defendant's Exhibit number 141.)

By MR. WHITCOMB:

Q. Will you now proceed with this Exhibit 62 and state whether these figures given as Dr. Clark's are correct or not?

A. If Dr. Clark certifies that those figures are a correct copy I will accept it without further investigation.

MR. WHITCOMB: Well, you do, do you not, Dr. Clark, the theoretical—

DR. CLARK: Well, did you check those calculated values on the slide-rule?

THE WITNESS: I have just now seen them, they have been away from my vision all during noon hour, because they were in the Clerk's desk, but if you will tell me that these correspond, that the first column corresponds to the best set of composite data you can find for your centrifuge sample, that the second column corresponds to theoretical planes corresponding to a lattice parameter of 5.38; that the third column corresponds to interplanar spacings calculated theoretically from a lattice parameter of 5.33, if you tell me that I will accept it without further question,—

DR. CLARK: I think it is all right.

THE WITNESS: —in the interest of expediting the case.

By MR. WHITCOMB:

Q. Then, in view of Dr. Clark's remark, you accept these, as you state?

A. Correct.

Q. Well, now, will you please take line for line and on the extreme left-hand side put the percentage of error that the first figure, 3.08, has, using Dr. Clark's figure 3.077 as the standard of comparison?

A. You will realize, Mr. Whitcomb, that that will take a certain amount of time.

Q. Yes, I do, but I think it is very important.

MR. MORRIS: May I make this—

THE COURT: It is all right, it may be very

important, but I might as well go out while he is doing it.

MR. MORRIS: I wonder if he can do this,—

MR. WHITCOMB: Sure, I think we could adjourn for ten minutes.

MR. MORRIS: —unless he is going to follow through on some other matters with that, why not let Dr. Davey do that tonight?

THE COURT: Well,—

MR. MORRIS: If you are going to follow through with it on something else, why, my suggestion is out of order.

THE COURT: Yes. Would you rather have it done now?

MR. WHITCOMB: Well, I would.

THE COURT: All right, let him go ahead. It will take about ten minutes, then?

MR. WHITCOMB: How long will it take?

MR. MORRIS: It might take a half an hour.

THE WITNESS: Is it permitted, Your Honor, to mark those percentages on the exhibit that has already been entered?

THE COURT: Yes.

MR. WHITCOMB: I would like that.

THE WITNESS: I am requested to mark it on an exhibit that have already been entered, is that right?

THE COURT: Well, is it the exhibit that have already been entered?

MR. WHITCOMB: One we entered ourselves.

THE COURT: Did you calculate the percentages?

MR. WHITCOMB: We haven't yet.

THE COURT: Has anybody done it?

MR. WHITCOMB: He has accepted the figures as they are on there.

THE COURT: I understand that, but nobody has calculated the percentage of difference.

MR. WHITCOMB: Estimated some of them, that is all.

THE WITNESS: If you will indicate, Mr. Whitcomb, about the degree of precision you wish for this work I can probably expedite it somewhat by making more approximate calculations.

MR. WHITCOMB: Well,—

THE WITNESS: For instance, here is 3.08 and 3.10, which is a difference of two, two parts in three hundred.

MR. WHITCOMB: Omit the middle one and take Dr. Clark's.

THE WITNESS: All right.

MR. WHITCOMB: On the basis of a hundred.

THE WITNESS: Well, you see, 3.077 to be compared with 3.08 would have to be called 3.08, as being closer to 3.08 than it is to 3.07.

By MR. WHITCOMB:

Q. Then you would call that accurate?

A. I would have to call that accurate.

Q. Hundred per cent?

A. Hundred per cent, correct. You have asked me to put down here the per cent error, you want zero per cent, not hundred per cent, don't you?

Q. All right, please write out a column "percentage of error".

A. Between the first column and the third column?

Q. Will you write that down, too?

(The witness wrote on Plaintiffs' Exhibit 62.)

By MR. WHITCOMB:

Q. What have you written there?

A. Per cent different between first and third columns.

Q. Yes, for line one you find no—

A. Line one I find no significant difference.

Q. Line two?

A. Line two, 2.61 from 2.66½ is about four and a half parts in 250, let's call it two per cent. If you come to the nearest per cent you are satisfied, are you not?

Q. I am satisfied.

A. Two per cent.

Q. The next line—

A. 1.84—

THE COURT: Well, you let me know when you get that done.

THE WITNESS: 1.84 to 1.88 is a difference of four in practically two hundred. We will call that two per cent.

MR. MORRIS: Mr. Davey, just put your figures down when you get them, without any filling in in the testimony, if you want to.

THE WITNESS: I didn't suppose I was giving



testimony, I thought I was checking with Dr. Clark.

(The witness entered the remaining percentages on Plaintiffs' Exhibit number 62.)

By MR. WHITCOMB:

Q. Dr. Davey, now, read the percentages of difference that you have listed in the extreme left-hand column of the sheet Exhibit 62.

A. I have listed the following under the title of per cent difference between first and third columns—

THE COURT: Now, wait, let me put that on mine.

THE WITNESS: Per cent difference between first and third columns, these are calculated by mental arithmetic, to save time of the Court.

By THE COURT:

Q. All right, what are they? Start with 3.08, what is the difference there?

A. Zero per cent.

Q. Yes.

A. 2 per cent.

Q. 2 per cent?

A. 2 per cent; zero per cent.

Q. Now, wait a minute, 1.84 is 2, is that right?

A. 1.84 is 2.

Q. All right.

A. Zero; 2; 2; zero.

Q. 2; 2—wait a minute, there is a blank there?

A. Then the next one is a blank.

Q. Zero, 2, 2, zero; then the next is blank?

A. Then the next is a blank.

Q. Then what?

A. The next one I have labeled, because of 1.33, no significant difference. I meant by that that the calculated value is only given to two decimal places, and, therefore, there is no significant difference—

Q. All right.

A. —Between that and the value found to four decimal places of 1.326.

Q. All right, next?

A. The next column is a blank, because there is no calculated value given.

Q. Yes.

A. The next one is zero.

Q. Yes.

A. And then 1.

Q. Yes.

A. 1,  $1\frac{1}{2}$ ,  $1\frac{2}{3}$ , blank,  $1\frac{1}{2}$ , and zero.

THE COURT: All right.

By MR. WHITCOMB:

Q. Then the maximum percentage of error you found was two per cent, is that right?

A. For these two columns, yes.

Q. And you have already checked the third column, labeled Dr. Clark's calculated values, with Plaintiffs' Exhibit P-46, and find them correct, did you not?

A. The third column? I have taken Dr. Clark's statement that they are correct and that he has checked them.

Q. You also checked them?

A. I checked the first column.

Q. Oh, I beg your pardon, the first column, I meant?

THE COURT: All right.

By Mr. WHITCOMB:

Q. I understand you to say that in your slide-rule an inch would give twelve per cent, about twelve and one-half per cent error?

A. Correct.

Q. Then—

A. At the portion where I calculated the error.

Q. Yes, and at a corresponding portion, then, an error of two per cent would be a leeway of between one-eighth and a quarter of an inch,—

A. I assume so.

Q.—is that correct?

A. As nearly as I can do mental arithmetic at present.

Q. Well, you agree that is about correct, then. Do mixtures of mineral ore, and so forth, have known chemical identifications?

A. I am sorry, the street car was raising such a racket I didn't hear all of the words.

MR. WHITCOMB: Will you repeat it?

(The question was repeated by the Reporter, as follows:

“Q. Do mixtures of mineral ore, and so forth, have known chemical identifications?”)

A. Not in all cases.

By Mr. WHITCOMB:

Q. Do proteins have known chemical identifications?

A. I am not an organic chemist, and am not qualified to give expert testimony along that line. I have been told by organic chemists that they have some definite formulas.

Q. They have definite formulas as to how they are put together, chemically speaking?

A. I think so. As I said before, I am not an organic chemist.

Q. Well, I am informed by our experts that they are not.

A. That is all right with me.

Q. Do you disagree with them?

A. I said I am not an organic chemist, and especially not a biological chemist.

Q. Well, do scientists have X-ray patterns for proteins?

A. Some of them.

Q. Do you know who Astbury is?

A. Yes.

Q. Who is he?

A. Astbury is a pupil of Bragg's, who is in charge of contextile research at Manchester, England.

Q. Do you know whether he has done anything in connection with X-rays on proteins?

A. Yes.

Q. Well, is your testimony that if there is no chemical, known standard with which to compare his results that his work is worthless on that basis?

A. I don't follow your logic. I have testified that I don't know, and that I am not an organic chemist, and certainly not a biological chemist.

By THE COURT:

Q. No, but he is going back to what you said in the very beginning, that if you haven't got any standard fingerprint to compare your found pattern with, that it is of no value. Now, would you apply that also to—

MR. WHITCOMB: Proteins, for example.

By THE COURT:

Q. —proteins, or any other substance?

A. Well, I have been told that certain proteins have a definitely established formula. I am not acquainted with the facts.

Q. I understand.

A. Just hearsay.

Q. Mr. Whitcomb is asking you if you assume there is no formula, does your testimony apply the same to proteins as it does to inorganic substances?

A. Yes, if there is no known formula for the protein, then it is not an identification.

Q. That is all he wants to know.

A. Except with one qualification.

Q. All right.

A. That if the protein can be identified by some qualitative test, so that you can definitely say by that qualitative test that this protein in this bottle is identical with this other protein in this other bottle, then the X-ray diffraction pattern might be an identification of the material in the bottle, without saying what the material is in the bottle, other than the fact that it is in that bottle.

Q. Yes.

By MR. WHITCOMB:

Q. I understood you to make some reference to solid solutions, Dr. Davey.

A. Yes, sir.

Q. Now, what is a solid solution, in your opinion?

THE COURT: I think he did define that. Do you want him to do it over again?

By MR. WHITCOMB:

Q. Well, I want to know, is it a chemically reacted substance?

A: I have written a whole chapter in a book with the intent of showing that solid solutions must have some kind of a chemical tie-up between the solute and the solvent, that that chemical reaction is not to be regarded as a chemical reaction between the solute and all of the solvent, but merely the atoms or molecules of the solute individually with certain immediately surrounding atoms or molecules of the solvent.

For instance, let me illustrate, if we have a solid solution of aluminum in silver, I have assumed in that chapter that we have instead of just aluminum atoms peppered around into the silver in a mechanical mixture of atoms, I have assumed and tried to give reasons for that assumption, that we have the compounds  $\text{Ag}_3\text{Al}$  peppered around in the silver, and that the aluminum can travel by giving up its combination with one silver atoms, making a combination with the silver atom on the other side, and in that way it can travel along, you might say hand over hand from one portion to the other, always, at any one instant, being  $\text{Ag}_3\text{Al}$ , with the same aluminum atom, but not necessarily the same three silver atoms. It is as if it divorced some of its wives and married still other ones, and kept that on in the process of travelling from one region of the alloy to another.

Q. Didn't you definitely state on page 530 in our book as follows:

"Of course this does not mean that the law of definite proportions can always be demonstrated, especially in the sense in which it is explained to students in elementary chemistry. It does mean that we must assume the forces acting between solvent and solute to be chemical in their nature and the energies involved to be truly chemical energies."

A. That is another way of saying exactly what I have just got done saying.

Q. Then it has a chemical identification?

A. It has a chemical existence, not in terms of the individual atoms of the solute and the whole body of the solvent, but rather it has an individual chemical existence with the atoms of the solute and the immediately surrounding atoms of the solvent. In that event of a chemical union between the atom of the solute and the immediately surrounding atoms of the solvent we have the true law of chemical proportions holding.

Q. Do you think, then,—

A. Of course, it would be nonsense to try to apply the law of chemical proportions in terms of the whole body of solvent, because there would be many atoms there entirely out of the sphere of chemical influence of the individual atoms of the solute.

Q. Yes, of course, I was not talking about the whole body, I was talking of any place where it occurred.

A. So what I have said is identical in intent with what you have read.

Q. Then is it your testimony that in these Exide samples there is a solid solution of lead and  $PbO$ ?

A. It was my testimony that we had a mechanical mixture of a material identified as lead and of a material identified as red  $PbO$ . As far as I know, I have said nothing about solid solution in Exide samples.

Q. Well, is it your testimony, that there is no solid solution in the Exide samples?

A. My testimony would be that if—if there is any solid solution it must be of extremely small amount.

Q. Oh, it might be of extremely small amount?

A. If you define extremely small amount as being a small enough amount, of course, you get it down below the limit of measurement, and then, of course, any answer is correct.



Q. And if that existed, then, it would be, according to your book and according to your testimony just now, the result of truly chemical energies and forces acting, is that correct?

A. Let me answer, first, yes, and then let me amplify that a little bit, for the purpose of expediting the case. I think what you are trying to head me into is to try to say there must have been some  $Pb_2O$  there. I am perfectly willing to admit that if you get some oxygen into the lead that you will have a compound between the oxygen and the lead, but we have three perfectly well-known oxides of lead,  $PbO$ ,  $PbO_2$ , and  $Pb_3O_4$ . Now, why pick on this  $Pb_2O$ , which has not been proved to exist, when you have three perfectly good oxides, any one or all of which may be used to fulfill the conditions outlined by the theory of solid solution?

Q. Well, what about the very initial process that starts when oxygen meets lead? Do you agree or disagree with Dr. Clark's theory about faking the oxygen into the molecule or atom?

A. As I understand Dr. Clark's testimony as to the initial stages of oxygen coming on to the surface of lead, he has given a version of Langmuir's well-known theory of chemical absorption,—

Q. Well, do you agree with him?

A. —which requires chemical action. I would agree that oxygen on coming in contact with lead would give any one of a number of chemical compounds as long as the chemical compounds are chemically possible, that all of those chemical compounds would attempt to decompose, each one attempting to decompose at its own rate for the temperature at which the experiment was tried, the less stable compounds would decompose more rapidly than the more stable compounds, so that eventually the stable condition would be that of the stable compounds.

I suppose you could write down a pageful of chemical formulas which might by some stretch of the imagination be assumed to be the chemical formula for an absorption compound lasting possibly a millionth of a second. If that is the interpretation to be given to your question I must say that you can take a great many compounds if you wish.

Q. And some of those might be in the ratio—

A. If you wish your—

Q. —of less lead than oxygen—less oxygen than lead,—

A. Yes, on the basis—

Q. —with oxygen—

A. On the basis—

Q. —of not more than one?

A. —of their lasting, say, not more than a millionth of a second, but if you want to know what a compound could be there, in the ordinary sense of the term "compound", then only the compound which persists is entitled to recognition, only the compound which persists for a length of time long enough to find it there is entitled to be called a chemical compound in the sense in which the term is ordinarily applied, in other words, in the sense—

Q. Then do you—

A. —in which it is applied outside of absorption compounds.

Q. Well, then, do you exclude your discussion, what chemical reaction goes on in the solid solution, as applying to such a condition as you last mentioned?

A. The compounds which I have described in my chapter on solid solutions are compounds which have a definitely known existence,—

Q. Well, that is not the question.

A. —and are compounds which actually appear in the alloy when the temperature and concentration are correctly adjusted.

Q. But that was not the question.

A. I am sorry, I thought it was.

Q. The question was, assuming the conditions you mentioned, of this small item of time as to when there might be the formation of the lead and the oxide, which would be broadly a suboxide, that is, in that there was one part oxygen and less amount—or more amount of lead, then would your chemical theory as announced in your chapter on solid solutions apply?

A. The theory in my chapter on solid solutions applies to the interior of the solid. What you and Dr. Clark have been talking about apply on the surface of the solid.

Q. Not limited to the surface, any action that goes on.

A. The theory of absorption is necessarily limited to the immediate surface. Otherwise it is not absorption.

Q. Well, what follows absorption?

A. After—after absorption you can have the production of the final chemical stable compound on the surface, and the migration of one or the other of the ions of that compound into the interior, the rate of that migration depending upon what the materials are, and the temperature, and to some extent, also, upon their state of impurity.

Q. Well, now, what part of your book on this question, the fact of truly chemical action in solid solution, limits it to surface action? Is there any?

A. It is well understood among physical chemists and metallurgists that solid solutions are intended—that the term “solid solution” is intended to apply to the whole mass of the material, and not to surface effects. It is well understood among physical chemists that the catalytic effects on surfaces are taken up—

Q. But you did not exclude—

A. —under entirely different categories.

Q. But you did not exclude the surface action, did you?

A. I was not writing a legal textbook.

Q. Well, then, you did not exclude it, did you?

A. I was not writing a legal textbook, and I was using the term "solid solution" in its ordinary, accepted scientific and engineering sense.

Q. Is it your testimony that when chemical  $\text{PbO}$  is formed the transfer from lead jumps immediately from the latticework of the cube, face centered cube shown on Plaintiffs' Exhibit 29, to the tetragonal form shown at the right-hand side of Exhibit 29?

A. To the best of my knowledge I have not testified so, but I would be willing to.

Q. Well, do you?

THE COURT: Yes, he says so. I understand that you do so testify in answer to that question.

THE WITNESS: Barring a slight expansion of the lead lattice, due to solid solution of oxygen in it, there should be no intermediate diffraction pattern possible, and, therefore, you should jump from a face centered cubic type of structure, giving a face centered cubic type of diffraction pattern, to the red  $\text{PbO}$  structure, which is a tetragonal, tetragonal type of structure. I know of no evidence which gives an intermediary type of diffraction pattern.

By MR. WHITCOMB:

Q. Well, what would the solid solution show?

A. I have already said that the solid solution would make a slight change in the lattice parameter of the lead.

Q. And would not approach the picture of the tetragonal litharge on the extreme right-hand of Exhibit 29 by any means, is that right?

A. The change from a cubic structure to a tetragonal structure must be a definite change, not a gradual change. It is to be assumed that the lattice of the lead, which is a face centered cubic lattice, could be stretched until further stretching would produce an unstable configuration of atoms and the attractions between atoms would immediately make the lattice jump to the other lattice. That is a matter of ordinary experience, confirmed by a great many chemical changes, and the change from one type of lattice to the other type of lattice is regarded ordinarily as a criterion of such change, and without the change from one lattice to another lattice it is assumed that there is nothing but solid solution.

Q. When you say that the structure stretches, I believe—

A. Some solid solutions cause stretching, and some cause contraction.

Q. Well, in the illustration you made—

A. I used stretching as an illustration.

Q. Well now, when that stretching occurred would a distortion also occur?

A. It depends upon circumstances.

Q. It might occur?

A. I know that in the case of non-cubic materials distortion occurs. I have never noticed any considerable distortion in a cubic crystal due to solid solution in the cubic crystal.

Q. How about iron and carbon?

A. There has been considerable controversy about the diffraction pattern of the compound  $\text{Fe}_3\text{C}$ . It is a difficult compound to get in a sufficient state of purity to settle all of the points in the controversy, so it is

very hard to tell when distortion of the iron lattice ceases and when you begin to get the beginning of some other compound.

I saw an article just the other day pending to show that there is still a second compound between iron and carbon, which is not the pure iron, which is not the  $\text{Fe}_3\text{C}$ , but is some other compound.

Q. What about Martinsite?

A. I have considerable difficulty in finding out what the word "Martinsite" means. I thought at one time I knew, I thought that Martinsite was a dispersion of  $\text{Fe}_3\text{C}$ , was a dispersed phase of a dispersion of  $\text{Fe}_3\text{C}$ . In talking to professors in our metallurgy department I find that they use the word "martinsite" to represent whatever it is they happen to have when they have iron and carbon present with certain heat treatments, they try to describe it in terms of photomicrographs, but they seem to be very indefinite in their terminology. I tried to be very definite and ran into trouble with the —ran into trouble in expressing myself so that the metallurgist could understand me, because they were necessarily indefinite in their use of the word.

Q. What would be, what would a distortion of a crystalline substance be, if it occurred?

A. That is a question something like asking what would the injury of a person be in an accident if it occurred.

Q. Do you think—

A. I don't know what distortion you have in mind, or what substance you have in mind, or anything of the sort.

Q. Well, haven't you any idea that at any time any of these crystalline substances take on any distortion and X-ray patterns of distortions have been taken, or is your testimony to the effect that it has never been?



A. My testimony is not to the effect that it has never been. It is quite likely that there might be some distortions, especially in the case of non-cubic crystals. In the case of cubic crystals I am not sure, I assume that the distortion in the case of the cubic crystal would iron out, because of the symmetries of the cubic type of crystallization, so that in the long run the distortions would be equal along all three axes, and, therefore, we would only get a change in lattice parameter.

Q. Well, how does PbO absorb oxygen to give  $\text{PbO}_{1.10}$ , for example? What transpires there?

A. Are you asking me what transpires, or what I guess transpires?

Q. Your testimony as to what transpires.

A. I have never studied the action of oxygen on PbO, going up to  $\text{PbO}_{1.1}$ , so that I cannot testify from personal experience, I would have to give you just a guess. I have asked you if that guess is what you want.

Q. What would that guess be? What is your best opinion? Of course, you are not talking about guessing—

A. Since PbO is a non-cubic crystal I would assume that there would be distortions producing a distorted crystal of less symmetry than the original PbO. I am basing that guess on what happens in the non-cubic crystal of zinc.

Q. Well, on the other hand, what would be the effect of a distorted form of crystalline substance on an X-ray pattern?

A. If a crystal were distorted so as to change its crystal symmetry the effect of the distortion would be to displace some lines much more than other lines. If the effect of the distortion is merely to produce a change in the average lattice parameter, than all of



the lines will be shifted so as to give a diffraction pattern corresponding to the original diffraction pattern, but with a slightly different lattice parameter.

(Discussion off the record.)

By MR. WHITCOMB:

Q. But in your book, page 534, you state?

"Irrespective of whether the lattice parameter is increased or decreased, the regions near the ions would be distorted and so would produce little or no x-ray diffraction pattern."

You don't mean to say it would not produce a diffraction pattern, though, do you?

A: If the distortion was local, so as to be only in a region, say, ten or twenty atoms across, the distorted pattern, distorted structure would be so small as to show no appreciable diffraction pattern.

Q. But if you had a very sensitive X-ray apparatus, compared with one that is less sensitive, you might be able to detect that, is that right?

A. That is something like saying that if I had a sensitive enough rule I could measure the distance from here to New York in terms of the wave length of light. If I have a sensitive enough rule I have a sensitive enough rule. That is the only interpretation to give your question.

Q. Well, do you think, from what you heard of Dr. Clark's discussion of the sensitiveness of the apparatus used by him in his X-ray patterns, that he might get some distorted substances whereas one like yours would not give these lines?

A. I have calculated for you some of the departures from the face centered cubic pattern of the diffraction patterns which you asked me to calculate. Those departures are of the order of two per cent,

and I have no difficulty in reading my diffraction patterns to an order of one per cent for each line, and Dr. Clark has an excellent apparatus, and he is very skillful, and he is able to produce data which from its own internal evidence shows that he can get to a quarter of a per cent, but with one per cent accuracy for each individual line, which I claim, I can certainly detect two per cent, I think.

Q. But some of these lines give practically no differentiation. Then in that case wouldn't his apparatus have been more accurate than yours?

A. You are confusing accuracy of the apparatus and accuracy of interpretation of the diffraction pattern. I have—I have admitted that Dr. Clark had a face centered cubic diffraction pattern.

Q. Well, I am not limiting to that, I am just asking if he is more liable to pick out a distorted pattern than your apparatus would?

A. He could pick out—

Q. Your testimony about the faintness of the line—

A. He could pick out a lattice which was a little more distorted than I could pick out, but the distortions in his lattice are still big enough so I can pick them out with my diffraction pattern, I suppose.

By THE COURT:

Q. Do you mean a little more or a little less distorted?

THE WITNESS: Will you please read my answer, and I can put the proper correction in it?

(The answer was repeated by the Reporter, as follows:

“A. He could pick out a lattice which was a little more distorted than I could pick out.”)

THE WITNESS: He can pick out a greater distortion than I can.

By THE COURT:

Q. Oh, is that what you mean?

A. Yes.

Q. Oh.

A. Not much greater, but a little greater; enough greater so that it is probably of academic interest.

By MR. WHITCOMB:

Q. Well, then, your last answer is to the effect in your opinion that there is X-ray apparatus more sensitive than the one you are using at your university, and might detect further information in respect to these patterns?

A. I have already expressed the greatest admiration for Dr. Clark's apparatus and for his skill, and I have admitted that he can make a—can make measurements with his apparatus which are enough more accurate than mine to be of academic interest.

Q. And the same would apply to his ability to pick out faint lines, as compared with what would show up with your apparatus?

A. Again, a difference only of academic interest.

Q. The same interest might have some interest in this case, might it not, some bearing on the issue?

A. Yes, I think it might. If Dr. Clark actually got the faint lines which he told Dr. Wilson about, and I assume he did, because he has showed evidence of still stronger lines in his centrifuge pattern, it might have some bearing on the case, but it does not prove that the faint lines corresponded to  $Pb_2O$ , if that is what you are driving at.

Q. Will you produce the samples that you used in your tests, and also the films?

A. I haven't had time to go over the films, I have them all right here, and the samples are on deposit with Professor Ullmann, in case they are asked for.

MR. WHITCOMB: Of course, we want the films in.

MR. MORRIS: Oh, sure, I will put the films in.

THE WITNESS: The films can go in immediately if you are willing to take them with the identifications on the film, or if you want them sorted out in some definite order it will take some time time to sort them out.

MR. MORRIS: I want you to sort them out. I want to put them in, and I will get you to sort them out now or a little later.

THE WITNESS: They are all in numerical order in these boxes.

MR. WHITCOMB: We reserve the right to further cross-examine if necessary.

MR. MORRIS: Sure.

MR. WHITCOMB: Also to the notebooks. I thought we could cover that—

MR. MORRIS: Sure.

*Re-direct-examination.*

By MR. MORRIS:

Q. Dr. Davey, I call your attention to the note on the bottom of Plaintiffs' Exhibit 53, Plaintiffs' Exhibit 53, which is apparently page 8 of Dr. Clark's research log, and I ask you, I direct your attention to the parenthetical expression in the note at the bottom and ask you what you have to say with regard to that.

(Plaintiffs' Exhibit 53 was shown to the witness.)

A. The note reads as follows: Note: It looks as if the sample obtained in this research contains some lead suboxide (if Ferrari had lead suboxide) and some other substance. The 2.23 and 2.11 lines look as if they might be lead sulfate lines".

Q. Does or does that not harmonize with the testimony that you have given with respect to the necessity for identification?

A. It does.

Q. Dr. Davey, in the beginning of your cross-examination you said something to the effect that had you made a longer exposure on your chart one you might have gotten additional lines. Will you explain that answer, and what additional lines would you have gotten, and why?

A. The lines from a given crystal—

Q. I am now referring to Defendant's Exhibit 137,—

A. Yes.

Q. —chart one.

A. The lines to be obtained from a given crystal are very large in number under ordinary circumstances. The lines corresponding to the large interplanar spacings are the ones which are most intense, and which register most easily on the photographic film. The smaller and smaller the interplanar spacings get, clear up to an angle of diffraction of ninety degrees, the weaker and weaker the diffracted lines become, other things being equal. For a given exposure on the photographic film the lines for large interplanar spacings are, therefore, more prominent than the lines for small interplanar spacings?

Q. Well,—

A. If we increase the length of the exposure we can bring out some of those weak lines, which may be so faint on the film as to escape notice entirely, those weak lines corresponding to the short, to the small interplanar spacings.

I do not mean to imply for a minute that we have introduced additional lines in the space covered by the chart, but rather that we would have been able to have extended that chart further toward the right.

Q. Do you mean or do you not mean that you would repeat farther to the right lines of the same character of those which you have on your chart already?

A. Belonging to exactly the same theoretical face centered cubic diffraction pattern, or whatever diffraction pattern it is.

Q. Do you or do you not mean that you would find in your diffraction pattern for lead lines that were not representative of lead?

A. I do not mean that longer exposure would bring out lines not representative of lead. I do mean that longer exposure would bring out lines of a greater diffraction angle than are shown with smaller exposures, but lines which fit beautifully with the theoretical diffraction pattern of lead.

Q. Would you have found, do you mean to say that you would have found or that you would not have found lines similar to those unaccounted for lines on Dr. Clark's diffraction pattern for lead, which is Plaintiffs' Exhibit 48.

(Plaintiffs' Exhibit 48 was shown to the witness.)

A. On Plaintiffs' Exhibit 48 the lines which are not accounted for by the checks would not have been brought out from pure lead by further exposure.

By Mr. MORRIS:

Q. Does your answer to my previous question about the time or length of exposure indicate that you may, or not, that you may have failed to get Dr. Clark's so-called  $Pb_2O$  lines by reason of the shortness of the exposure of your film?

A. No, I exposed my films up to the limit to which the photographic film was capable, and still have a readable diffraction pattern.

Q. So that the absence of the alleged  $Pb_2O$  lines on your film cannot be accounted for in your opinion in that wise?

A. Correct.

Mr. MORRIS: That is all.

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Mr. WHITCOMB: Counsel for plaintiff wants to offer in evidence the article by Le Blanc for identification as Plaintiffs' Exhibit number 63.

(Article by Le Blanc was marked Plaintiffs' Exhibit number 63 for identification.)

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HAROLD V. ANDERSON, was called as an expert witness on behalf of defendant and having been first duly sworn, testified as follows:

*Direct-examination.*

By Mr. MORRIS:

I am an associate professor of chemistry at Lehigh University. I have been such since 1930; five years. In the year '28-'29 I attended the University of Illinois as a graduate student under the tutelage of



Dr. George L. Clark, the plaintiffs' witness in this case. In the fall of that year of '29, I returned to the Lehigh University and established a laboratory to carry on work in the field of X-ray diffraction, and also began a course of X-ray technology.

Q. Have you done any work in connection with the Defendant's product in this case?

MR. WHITCOMB: If your Honor please, we make the objection, we understood the fundamental point of patent practice to avoid burdensome expenses was to have one expert for one thing on each side. Under the old practice, under the old rules, they used to take expert after expert, and that was one of the things that was desired to be overcome. Now, of course, each side could go out and get another expert, and the other side goes out and gets a third, and so on, ad infinitum.

THE COURT: Yes, well, is there a rule directed to that? I don't know.

MR. WHITCOMB: Well, I think it is an unwritten rule, I don't think there is any definite rule, but it seems to me, I have had it invoked against me, and unless there is some reason for going on and on, we have been operating under the theory that that would be the rule. It should be, I think, because it is only a question of going out and hiring some more professors from some more colleges, and getting them in. Now, when you get down below Dr. Davey and Dr. Clark they are not so expensive.

MR. MORRIS: In the first place, there isn't such a rule. In the second place, if there were it should not apply, after in the year A. D. 1935 an alleged new compound has been found, and if there is any

work that anybody has done specifically in search for that compound it should be revealed to the Court, to enable the Court to determine its existence or non-existence, and what has happened to us in this case? The only evidence of infringement, so far as I know, if there is any, is a couple or perhaps eight lines on a sheet of paper, to wit, a camera film which Dr. Clark tells us is a  $Pb_2O$  line. Are we going to let it pass at that, if that is any evidence of infringement, and I doubt it, but that is the evidence of infringement, alleged infringement with which we are here confronted, and I should think we would be able to refute that by as many witnesses as we can have to testify with respect to that, and I may serve notice on the learned counsel for Plaintiff now that I propose to call, with your Honor's permission, not only Dr. Anderson, but also Dr. Ewing, who has used the microscope and other tests.

MR. WHITCOMB: Well, I am limiting it to the X-ray; one expert for one purpose.

MR. MORRIS: Oh.

MR. WHITCOMB: That is the fundamental rule.

MR. MORRIS: We have tried not only once, but we have tried doubly, with a series of experiments which are indicated by the pile of documents in Dr. Anderson's hands, to see with all the skill and care of which he is possessed, if he can find any evidence of these alleged  $Pb_2O$  lines, and I do not hesitate to say at the moment that he has found no such suggestion. We propose, with your Honor's permission, to prove it.

THE COURT: All right. Of course, you will agree that there should be some limit.

MR. MORRIS: Well, we have down with us a rule that no more than six witnesses shall be called to the same point, and that is a different apparatus, also, and if two people at different places, working independently, and with all seriousness and all endeavor, who present their work here, not in three or four loose sheets, but in bound volumes, showing page after page of effort to find it, and precisely what they found, then I think that is a very great corroborative and accumulative evidence.

MR. WHITCOMB: I should think if we were going to go on and on like this it might be that the Court should appoint somebody to get a really independent—

THE COURT: Well, the Court has appointed somebody, but he is not an X-ray man.

MR. WHITCOMB: Well, that is it. Of course we want to reserve the right to take five more experts on X-ray, now.

MR. MORRIS: I suspected—

MR. WHITCOMB: I do not mean that actually.

MR. MORRIS: I suspected that, if your Honor please,—

MR. WHITCOMB: If we are going to be confronted with three or four here, just the mere weight of numbers we have to consider.

MR. MORRIS: I suspected—

MR. WHITCOMB: Although I guess Dr. Clark equals two or three of the average.

MR. MORRIS: I suspected that because of the

thinness of the prima facie case, but the prima facie case is the Plaintiffs' opening case, and his rebuttal is rebuttal, and I shall insist on that in this case, that is, the Plaintiff may not split in a patent case any more than in any other his case. He may, of course, in a patent case, as well as in any other, produce rebuttal evidence, but he cannot bolster up his case—

MR. WHITCOMB: But he can rebut the Defendant's case—

MR. MORRIS: Sure, he can,—

MR. WHITCOMB: by X-rays.

MR. MORRIS: —if he can.

MR. WHITCOMB: By X-rays.

MR. MORRIS: Well, I have nothing more to say.

MR. WHITCOMB: I think it is serious.

THE COURT: Well, I will take it, and note the objection, but I do suggest that it be made briefer than Dr. Davey, if possible.

MR. MORRIS: I think I shall have only two questions to this witness.

THE COURT: All right. There is something to be considered in regard to the cumulative nature of the testimony.

MR. MORRIS: Will you read my question?

MR. WHITCOMB: Of course, we would like that reservation that we may need to prevent further X-ray experts.

THE COURT: Well, I will have to meet that

when it comes. You cannot make any reservation to something you are not entitled to, and if you are entitled to it you don't need a reservation.

MR. MORRIS: This is to refute?.

THE COURT: If you want to call another expert we will have to meet that situation.

MR. MORRIS: Will you read the question, please, Mr. Rodebaugh?

(The question was repeated by the reporter, as follows:

"Q. Have you done any work in connection with the Defendant's product in this case?")

A. I have.

By MR. MORRIS:

Q. What, and what did you find?


A. I have examined all of the official samples of gray oxide which were submitted to me and signed by Dr. Wilson, and in the examination I have found nothing more than metallic lead and red tetragonal PbO.

Q. What instruments did you use and under what precautions did you make your tests?

A. The X-ray apparatus that I used was an X-ray tube equipped with a copper target, and the specimen—each specimen placed into a small capillary tube, in an atmosphere of nitrogen. At the end of each tube, sample tube, was inserted a cotton plug, and the tube sealed with sealing wax, and that specimen tube was mounted in what is known as an X-ray photo gonimeter.

The well-known powder method of X-ray analyses was used, using a cylindrical camera, and the specimen was rotated during the time of the exposure.

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The registrations, of course, coming from the various crystal planes were registered on the photographic plate or film in this cylindrical camera. Then the films were developed and each one of these films were measured with the highest possible precision, and the various calculations undergone to arrive at the interplanar spacings that are characteristic of the material.

Q. Had there been any material in the samples tested by you of the nature or character of that represented by the lines in Dr. Clark's Exhibit 21, number 6, would or would not your investigation have disclosed it?

A. I feel certain that if it was there in any quantity at all above one per cent I should have been able to detect the most intense line of that diffraction pattern.

Q. Dr. Anderson, have you made any experiments recently with the X-ray, by the X-ray method, with respect to lead oxalate?

A. I have, I have conducted a number of experiments trying to duplicate the work of Ferrari, just as Dr. Clark has done. Each time that we attempted to duplicate the pattern we obtained the composite diffraction pattern of metallic lead and red tetragonal  $\text{PbO}$ . In other words, we checked the work, the original work of van Arkel, and we were careful in these—I might mention that these specimens were all prepared under the direction of Or. Ullmann, who can tell us the exact manner in which they were prepared.

Q. And did you give me the result of your X-ray analysis of the sample containing lead oxalate?

A. In the case of the more recent experiments we have found a number of diffuse lines from a specimen of the decomposition of lead oxalate after a period of two hours, as I have been told, which conform to some



of those lines of the Ferrari type of pattern. We find that they emulate those of undecomposed lead oxalate.

Q. Dr. Clark testified that he subjected the lead oxalate to a decomposition process for a period of two hours. Have you any experience with such matters, and can you tell me whether or not it can be decomposed under a vacuum, under a pump, within two hours?

A. We tried the experiment of decomposing lead oxalate at a temperature of 310 degrees, and the diffraction pattern of that material gives us these foreign lines, and we can attribute them to, some of them to metallic lead, some to red  $\text{PbO}$ , and others to undecomposed lead oxalate, and possibly some lead carbonate.

The reason I say that is this, that in the process of decomposition the greatest care and precaution was exercised in preparing this material, and in order to determine the exact pressure of the reaction flask it was subjected to a space discharge, and as long as any gas was evolved there was a discharge, a visible discharge, and that visible discharge did not disappear until after a period of, as I understand it, eight hours, which would indicate that there was still some material which had not been decomposed.

Q. Have you the measurements for this test, last test, which you have referred to?

A. I have.

By THE COURT:

Q. You did not see any of Dr. Clark's tests made, did you?

A. I did not, sir.

Q. You have his report and his testimony. Can you tell me in just a few words why you think that I ought to accept your opinion rather than Dr. Clark's on this matter?

A. Well, as far as my experience goes in this field in the past two years, working with these oxides of lead; I have endeavored to carry on the work to the highest degree of precision possible, —

Q. Do you think you have—

A. —and have been able to—

Q. —had a higher degree of precision than Dr. Clark?

A. I feel that I have, sir, and I have been able to reproduce all of the spectograms that have been published in the literature of stable compounds, so that I know that the apparatus is properly calibrated.

Q. What do you think, without going into it in too much detail, what do you think is wrong with Dr. Clark's conclusions?

A. Well, my personal opinion is that I think he had some undecomposed lead oxalate in his oxalate decomposition product, for the simple reason that—

Q. Well, but he made a lot of analyses other than the lead oxalate direct.

A. Yes, I realize that.

Q. He used that, I understand, merely as a check. He found his  $Pb_2O$  lines in the mill oxide and in the Exide oxide.

A. Well, we have tried to determine those,—

Q. Well, I understand—

A. —detect those.

Q. —you didn't find them?

A. No.

Q. I understand you didn't find them?

A. No, we couldn't locate them.

Q. I am assuming that you are both testifying in good faith. I am asking you what you think is wrong with Dr. Clark's results. How did he come to find them, or how did he come to think that he finds them?

A. Well, I don't know that I could answer that

particularly, because there are so many things that may enter into this—

Q. Well, of course, if you prefer not—

A. —diffraction pattern.

Q. It is, of course, in line with my own objection to this kind of testimony, but if you prefer not to criticize his method or testimony that is perfectly all right.

A. No,—

Q. I just wondered if—

A. —I have no criticism as far as Dr. Clark's method of analysis is concerned. I think he does a wonderful job of it.

Q. He does a wonderful job, but he gets exactly the opposite result from what you get.

A. Well, I feel that we have a difference in material and—

Q. Do you both do wonderful jobs?

A. With the methods that are considered reliable to the detection of as much as four per cent of a material I should be able to get the diffraction pattern of that material just as well as Dr. Clark.

Q. Well, it looks to me—

A. I don't get it.

Q. —as if somebody did not do a wonderful job here, or you could not have arrived at exactly opposite results. I don't know who it was, but—

A. I have my films and all of my measurements are here, so that I am able to show everything I have done.

THE COURT: That is all right, I am not suggesting anything that I think about it at all. I just was wondering.

By Mr. MORRIS:

Q. Are you of the opinion or not that whatever

may be represented by the lines, so-called  $Pb_2O$ , in Dr. Clark's film illustrated by his Exhibit 21, number 6—

MR. MORRIS: Will you read me that, please, Mr. Rodebaugh?

(The question was repeated by the reporter, as follows:

“Q. Are you of the opinion or not that whatever may be represented by the lines, so-called  $Pb_2O$ , in Dr. Clark's film illustrated by his Exhibit 21, number 6—”)

By MR. MORRIS:

Q. —was present in any of the Exide samples tested by you?

A. I am of the opinion that they were not present.

By THE COURT:

Q. Do you think those lines were present in the samples tested by Dr. Clark?

A. I don't know.

THE COURT: All right.

By MR. MORRIS:

Q. Did you make like tests with regard to the Toronto product?

A. I did.

Q. Official samples?

A. Official samples. I made what we call comparison spectra.

Q. With what result?

A. With the fact that they coincide exactly with the mechanical mixture of lead and red  $PbO$ .

Q. Did the Toronto product have any of the so-called  $Pb_2O$  lines in it at all?

A. Not that I could detect.

Q. Do you remember how many tests you made of that?

A. I can't recall offhand, but I have examined all of the specimens that were submitted from the Toronto experiment in January, and the comparison spectra of each one of those samples coincide.

Q. And none of them show any of the so-called  $Pb_2O$  lines?

A. That is true.

Q. Dr. Anderson, did you send a sample or samples to Dr. Davey?

A. I did.

Q. He has testified that he had one sample which was designated by number and he was not given any information with regard to its source. Do you recall sending him such a sample?

A. Yes, sir, that was sample number 28, so labeled.

Q. And what was the source of that sample?

A. That sample was one which was submitted to me by Mr. Hall in person, Mr. C. A. Hall. He did not tell me at the time the sample was given to me where it came from?

MR. MORRIS: Will you read me the last answer?

(The answer was repeated by the Reporter, as follows:

"A. That sample was one which was submitted to me by Mr. Hall in person, Mr. C. A. Hall. He did not tell me at the time the sample was given to me where it came from.")

MR. WHITCOMB: Of course, we have to object to that, then, as not showing it is connected with the case.

THE COURT: Well, I suppose they will connect it up.

MR. MORRIS: What Mr. Whitcomb wants to know is whether I am going to call Mr. Hall. I am.

THE COURT: Sure.

MR. MORRIS: Objection withdrawn?

MR. WHITCOMB: Well, let it stand.

MR. MORRIS: All right.

By MR. MORRIS:

Q. Dr. Anderson, will you be good enough to tell me how the oxalate oxide lines which you have testified to a moment ago compare with or differ from Ferrari's spectrum—diffraction pattern?

A. I have the diffraction pattern of lead oxalate and—is it the decomposition product, did you say, Judge Morris?

Q. Yes, the ones you just testified about on a two-hour decomposition of oxalate oxide.

A. This was a lead oxalate decomposition product after two hours at 310 degrees plus or minus 2, under a vacuum, and I find in this spectrum several lines which conformed to undecomposed lead oxalate.

Q. Did you give the measurements for those lines or say how they compare or differ? You needn't do it specifically.

A. I have it here. The lines, the 2.60 line which I find on the undecomposed, or, rather, on the lead oxalate decomposition product corresponds to a line on—I would say within the limit of error—with that of the oxalate, and a 2.48 line on the lead oxalate decomposition with the 2.45 on the lead oxalate itself; a 2.34 on the lead oxalate and a 2.32 on the decomposition prod-

uct; a 2.13 on the lead oxalate and a 2.16 on the decomposition, and there are other lines in here which I could mention.

Q. Then what would you say generally with respect to how Ferrari's alleged  $Pb_2O$  lines can be accounted for on a theory other than a  $Pb_2O$  theory, if you can account for them otherwise?

A. My understanding is that Ferrari's material was an impure substance, and when treated with an acid effervesced, which indicated the presence of a carbonate, and it is just possible that he had a lead carbonate in there to correspond to some of his lines.

Q. In some oxalate?

A. In his lead oxalate.

Q. So that in this test which you have made you have found or not some ground for accounting for some or all of Ferrari's lines?

A. We have accounted for most all of Ferrari's lines.

Q. On this test—

A. Yes.

Q.—that you have just referred to. Have you your work sheets and films there?

A. Here are the films.

Q. All of them?

(The witness produced the records.)

By MR. MORRIS:

Q. These are what?

A. The first one, this is the lead oxalate decomposition product after two hours at 310.

MR. MORRIS: Which I offer as Defendant's Exhibit 142, and the film as 142-A.

(Work sheet showing lead oxalate decomposi-



tion product after two hours at 310 degrees, produced by the witness Anderson, was marked Defendant's Exhibit number 142.

Film showing lead oxalate decomposition test was marked Defendant's Exhibit number 142-A.)

By MR. MORRIS:

Q. Dr. Anderson, I notice that this film is not of the same length as those produced by Dr. Clark. Will you tell me why?

A. These are taken by the General Electric diffraction unit, which employs a larger radius.

Q. And is this film on the quadrant?

A. On the quadrant of the circumference, called a quadrant cassette.

Q. While your copper diffraction camera, where you get the copper method, your camera uses this in the circumference of a cylinder?

A. That is right.

Q. And that is a shorter film?

A. That is a shorter film.

Q. All right, you have some copper film, some molybdenum?

A. I have.

Q. And this quadrant is a molybdenum film, while the shorter films of those are copper target?

A. Yes.

Q. All right, now, will you give me that sheet you had a while ago and tell me what it is?

(The witness produced another work sheet.)

By MR. MORRIS:

Q. Number one represents what?

A. Lead oxalate.

Q. Lead oxalate, and what does column number two represent?

A. Another reading.

Q. For the lead oxalate?

A. Yes.

Q. That is, for the same test or another test?

A. That is the reading of the same film, only read by another person.

Q. Columns one and two, then, on this sheet, which is Defendant's Exhibit 143, represent readings of the same film by two different people?

A. Right.

(Work sheet entitled "Transcription of oxalate films", produced by the witness Anderson, was marked Defendant's Exhibit number 143.)

By MR. MORRIS:

Q. And the film from which those readings were made is the one annexed to it?

A. That is right.

MR. MORRIS: Which I offer as 143-A.

(Film of lead oxalate test related to Defendant's Exhibit 143 was marked. Defendant's Exhibit number 143-A.)

By MR. MORRIS:

Q. Now, can we bunch the rest of your work sheets and films?

A. Yes.

(The witness produced other records.)

THE WITNESS: Here is mechanical mixture of lead and PbO. These samples that I am submitting now are all gray oxide.

MR. MORRIS: I find these cannot be bunched as one without confusion, and it will take two or three minutes to separate them, that is all.

By MR. MORRIS:

Q. This sheet is X-ray analysis of  $PbO$ , of Pb and  $PbO$ ?

A. Right.

Q. Of a mechanical mixture 67.51 per cent of  $PbO$ , and 32.49 per cent of Pb?

A. Yes, sir.

Q. And the film is a copper film, copper target film from which the readings were taken?

A. Exactly.

MR. MORRIS: I offer it in evidence as Defendant's Exhibit 144, and 144-A, two sheets, but the film is "A".

(Two sheets entitled "X-ray analysis of Gray Oxide. (Finished Product) 2d Official Sample" were marked Defendant's Exhibit number 144.

Film related to Defendant's number 144 was marked Defendant's Exhibit number 144-A.)

By MR. MORRIS:

Q. These sheets which you now hand me together with the films represent X-ray analysis of gray oxide, finished product, with the films, with the measurements thereon of the films annexed thereto?

A. That is right.

MR. MORRIS: Which I offer in evidence as Defendant's Exhibits 145 to 151, inclusive, with the films annexed to each of those exhibits being given the "A" marking for that number.

(Two sheets entitled "X-ray Analysis of Gray Oxide, Finished Product (1st Official Sample)" were marked Defendant's Exhibit number 145.

Film related to Defendant's Exhibit number

145 was marked Defendant's Exhibit number 145-A.

Two sheets entitled "X-ray Analysis of Gray Oxide—Under Screen (1st Official Sample)" were marked Defendant's Exhibit number 146.

Film related to Defendant's Exhibit number 145 was marked Defendant's Exhibit number 146-A.

Two sheets entitled "X-ray Analysis of Pb and PbO (Mechanical Mixture 67.51% 32.49%)" were marked Defendant's Exhibit number 147.

Film related to Defendant's Exhibit number 147 was marked Defendant's Exhibit number 147-A.

Two sheets entitled "Lead Ball taken from inside of Mill near discharge and (J. H. W.) X-ray Analysis of Powder from Surface of Lead Ball" were marked Defendant's Exhibit number 148.

Film related to Defendant's Exhibit number 148 was marked Defendant's Exhibit number 148-A.

Two sheets entitled "X-ray Analysis of Gray Oxide (Under Screen) 2d Official Sample" were marked Defendant's Exhibit number 149.

Film related to Defendant's Exhibit number 149 was marked Defendant's Exhibit number 149-A.

Two sheets entitled "X-ray Analysis of Gray Oxide (Screen Product over  $P_2O_5$ )" were marked Defendant's Exhibit number 150.

Film related to Defendant's Exhibit number 150 was marked Defendant's Exhibit number 150-A.

Two sheets entitled "X-ray Analysis of Gray Oxide (Finished Product over  $P_2O_5$ )" were marked Defendant's Exhibit number 151.

Film related to Defendant's Exhibit number 151 was marked Defendant's Exhibit number 151-A.)

By MR. MORRIS:

Q. Dr. Anderson, have there been people as disclosed by the literature who have attempted to follow Ferrari and have written with regard thereto?

A. There have.

Q. Do you happen to have the Ferrari publication and the publications of such other persons?

A. I have. I have made abstracts of each one of those.

MR. MORRIS: I don't want the abstracts, unless the publications are too long. I may have in my files copies of those, and when they are collected, I will collect them during recess, if I have them, and offer them then.

THE COURT: Yes.

MR. MORRIS: Otherwise, direct examination closed.

By THE COURT:

Q. Just let me ask one question, this lead suboxide, now, you are getting into the general state of the literature, this lead suboxide was first mentioned by Berzelius a hundred years ago?

A. In the chemical literature it was mentioned.

Q. And since that time do most ordinary textbooks, elementary books and that sort of thing, include it?

A. Yes, it has been included in practically every chemistry text in existence. It was not until 1925, when we had the X-ray method, that van Arkel, in working with other suboxides, such as nickel, partic-

ularly attempted to show that nickel suboxide was made up of metallic nickel and nickel oxide,  $\text{NiO}$ , and this led him to a study of lead suboxide and from the decomposition product of lead oxalate he made an X-ray spectogram and published his results, and then he came forth with the diffraction pattern, composite diffraction pattern of metallic lead and red  $\text{PbO}$ .

Q. Was that before or after Ferrari made his—

A. That was published before Ferrari's work was published, but Ferrari knew of van Arkel, van Arkel's results, while he was undergoing his experiments.

Q. And then—

A. And he published anyway, in spite of the fact that he knew there was a disagreement, and since then, of course, there have been many workers who, as Dr. Clark has said, have attempted to duplicate Ferrari's work, which he himself has never been able to reproduce, and the dozen or more times that we have attempted to reproduce it, each time we have failed, in spite of our careful technique.

By Mr. MORRIS:

Q. One thing that I want to make sure of, did you compare a moment ago your lead oxalate decomposition lines and measurements with Ferrari's lines and measurements?

A. Yes.

Q. Now, I am told that we did not. Won't you check?

A. You mean—will you state the question again, please?

Q. I thought a moment ago that I had asked you to compare your two-hour oxalate oxide lines with Ferrari's lines. I am told by my associates that we did not make comparison. I thought we did. Let's do it and make sure. I want the lead oxalate pattern, dif-

fraction pattern, and the lines on that compared by you with Ferrari's spectogram.

A. I think that was submitted as one of the exhibits.

Q. Will you come down and find it?

THE COURT: Well, that is all you want to ask him, is it?

MR. MORRIS: That is all.

THE COURT: Well, then, suppose we recess for ten minutes.

(Recess at 3:45 o'clock P. M.)

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HAROLD V. ANDERSON, recalled.

*Direct-examination (Continued).*

By MR. MORRIS:

Q. Dr. Anderson, supplementing my last question, I hand you Defendant's Exhibit—

A. No, the next one.

Q. —143, and ask you to compare your lead oxalate measurements not only with Ferrari but with the Clark film and with the Shields film, which is one of the work sheets produced by Dr. Clark, and show how the oxalate lines coincide with the Clark additional lines and the Ferrari additional lines, if they do so coincide?

A. The first line on the lead oxalate coincides exactly with that of the first line of Clark's film, and is a 3.30 spacing in each case.

The next lines that corresponds is a 3.03 on the oxalate, which corresponds to a Ferrari 3.08.



The next line that corresponds with the oxalate is a 2.68 lead oxalate with a 2.64 Clark, 2.65 Ferrari, and a 2.66 Shields.

The next line that corresponds is a 1.88 lead oxalate, which corresponds with a Ferrari 1.87.

The next is a leadoxalate line 1.843, which corresponds with a Clark 1.84.

The next line is a 1.669 lead oxalate, which corresponds with a 1.66 on Shields.

The next line is a 1.61 lead oxalate, which corresponds to a 1.60 Ferrari.

The next one is a 1.57 lead oxalate, which corresponds to a Clark 1.58 and a Shields 1.59.

And, then, a line on the lead oxalate 1.241, which corresponds to a Clark 1.24 and a Shields 1.25.

Those are the major correspondences.

MR. MORRIS: I offer in evidence, if your Honor please, the article by Ferrari, which has been referred to numerous times, as Defendant's Exhibit 152.

(Said article was then marked as Defendant's Exhibit No. 152.)

MR. MORRIS: I offer in evidence, as Defendant's Exhibit 153, the article by Le Blanc and Eberius, entitled, "Investigations on the Existence of Lead Suboxide  $Pb_2O$ ", which has been referred to.

(Said article was then marked as Defendant's Exhibit No. 153.)

MR. MORRIS: As Defendant's Exhibit 154, I offer in evidence the article by Friche and Ackerman, "On the Existence of Lead Suboxide  $Pb_2O$ ".

(Said article was then marked as Defendant's Exhibit 154.)

MR. MORRIS: As 155, the van Arkel article, concerning the so-called suboxide of lead.

(Said article was then marked as Defendant's Exhibit No. 155.)

THE COURT: Let's see the van Arkel article.

(Discussion off the record.)

MR. MORRIS: As 156, the article by Darbyshire, entitled "An X-ray Examination of the Oxides of Lead":

(Said article was then marked as Defendant's Exhibit No. 156.)

(Discussion off the record.)

By MR. MORRIS:

Q. Dr. Anderson, I will ask you whether any of those persons, other than Ferrari, were able to find the so-called  $Pb_2O$  pattern?

A. They were not able to find the so-called  $Pb_2O$ .

Q. So you are not alone, Dr. Anderson, in being unable to find any of this product unless you turn to the oxalate in the Ferrari or the Clark lines?

A. No, I was not.

THE COURT: All right. Here's van Arkel.

MR. MORRIS: Cross-examine.

*Cross-examination.*

By MR. WHITCOMB:

Q. Dr. Anderson, I wanted to have one of the Plaintiff's films in possession at the same time, but take one of your films—Exhibit 144-A, that shows both sides?

A. Yes, sir.

Q. As compared with Dr. Clark's films, his films are only one-half the size of yours?

A. That's right.

Q. Dr. Clark's film is about five and a half inches and your half is what?

A. Probably in the neighborhood of three and a quarter inches. The radius is three centimeters.

Q. Then, in round numbers, by the same token, his would be about twice as accurate as yours?

A. Not necessarily so, I should say. I feel that those lines, as they are registered on the film, are extremely sharp and hair lines, so to speak, and are very easily measured with a viewing box and a pair of machinist's dividers.

Q. But, even so, they are not as easily measured, especially as to spacings, as Dr. Clark's lines with his six-inch film. Is that right?

A. As I look at Dr. Clark's film, or rather his Exhibit 21, I think these lines are resolved just as well.

Q. But all the lines you have are about three inches, and those that he has are spread over about six inches of film?

A. That is right.

Q. You induced some General Electric films, I believe?

A. Yes.

Q. But not with a copper target?

A. With a molybdenum target.

Q. And you worked with Dr. Clark. So, as you recall it, would you consider that he would rely on those General Electric films?

A. Well, the copper we have, it is as long as that of the molybdenum and will bring in the large spacings. It will bring in the large spacings much more readily than the shorter. We have the length, I am sure. I think the General Electric unit has its value in readily

obtaining interplanar spacings. I must admit the lines are not as sharp on the General Electric films as they are on the copper films when the specimen is rotated. As long as we have standard on the same film, in the case of the General Electric unit, it enables us to get very accurate measurements.

Q. But if you had the two—the film taken with the molybdenum and the one taken with the copper, as Dr. Clark testified he had both—would you expect him to rely only, primarily, on the one taken with the copper tube? Is that right?

A. For spacing measurements, yes.

Q. What about the fogging in the background?

A. In the case of the copper rays, I don't think that there is such an enormous amount of fogging here that will show.

Q. But I am speaking of your General Electric.

A. With the General Electric, there is more fogging than there is with the copper.

Q. Not only more but it is decidedly noticeable, isn't it?

A. Yes.

Q. In your opinion, could lead oxalate be found in the mill oxides, the Exide oxide?

A. No.

Q. Then, how do you account for the lines which you say correspond to the lead oxide to the lead oxalate lines on the film that Dr. Clark had of the Exide oxide?

A. Well, there's just the possibility that since there is carbon dioxide in the atmosphere that lead carbonate may be formed, and lead carbonate which has a— which has been analyzed by, I believe, Zachariasen, Chicago, and the lattice constants are published by Wyckoff and other literature—that, if we take these things into consideration, you will find that there are

some of those spacings on lead carbonate that correspond very closely to those of the lead oxalate, but it is just possible that lead carbonate was present; not only it may be present in gray oxide, and it was undoubtedly present in Ferrari's.

Q. But you didn't make any tests for carbonate, did you?

A. The carbonate? I have not obtained pure lead carbonate or as a diffraction pattern of pure lead carbonate.

Q. Then, you don't know whether there is any carbonate line or lines in Dr. Clark's films or not, do you?

A. There is a method whereby you can evaluate these axial lengths and axial ratios by means of curves—that is, place the spacings on these curves—and actually determine the planes that are responsible for the reflections, and we will find—if we plot the spacing on a logarithmic scale and make our matches on the Davey chart, we will find—in the orthorhombic system, I believe it is—that there is a correspondence.

Q. But you haven't done that?

A. I haven't done it personally, but I have seen Dr. Davey go through the same details.

Q. You were present when Dr. Davey listed the different variations from the theoretical on Plaintiff's Exhibit 62, were you not?

A. Yes.

Q. Do you remember the maximum variation found, theoretical to the actual, thus listed by—theoretical to actual values listed by Dr. Clark was two per cent. Is that correct?

A. Yes.

Q. Now, these checks that you have attempted to make of lead oxalate and read into the record this afternoon, they vary at least by two per cent, do they not?

A. I should say so. The lines are diffused. That is characteristic of an organic compound.

Q. Some of them vary much more than that, I believe?

A. It is just possible.

Q. The measurements for the undecomposed lines for oxalate correspond with those lines listed by Dr. Clark as suboxide lines?

A. May I see those spacings, please, sir?

Q. (Paper handed to witness.)

A. No, they do not.

Q. Then, to that extent, your testimony does not find the correspondence that you mentioned?

A. There were matches which would indicate that there are lines corresponding to lead oxalate.

Q. Well, it—so several compounds, like ten compounds of the patterns, show corresponding lines between miscellaneous ten compounds?

A. Yes, there are many instances of that; in fact, I can take the Ferrari spacings and match up a great many of them with orthorhombic yellow PbO. There are also some red PbO lines.

MR. MORRIS: Where?

THE WITNESS: In the Ferrari pattern.

MR. WHITCOMB: That is all.

*Re-direct-examination.*

By MR. MORRIS:

Q. Then you find in Ferrari's lines, if I understand your last two answers, lines which correspond with your red PbO lines and your orthorhombic or yellow PbO lines?

A. Mostly yellow PbO lines, and one or two red PbO.

Q. How many of his lines, of Ferrari's, can be accounted for by the PbO in its tetragonal and its orthorhombic crystal form?

A. I will give you that in just a minute.

Q. If you haven't that now—

A. I can find it; I have it right here. I have my other copy, and it won't take but a minute.

(Discussion off the record.)

THE WITNESS: I find the match in the theoretical yellow PbO of Ferrari's pattern of twelve lines, and four on the red PbO.

By MR. MORRIS:

Q. So that sixteen of Ferrari's lines can be accounted for not only by the oxalate but also by—my question is wrong and it is withdrawn. So that you can account for sixteen of the Ferrari lines by red PbO and yellow PbO. Is that right?

A. That is right. That is, those lines on the Ferrari pattern—

Q. Match?

A. —correspond to the theoretical spacings of yellow PbO. That's twelve lines on the yellow, and there are also four lines on the red PbO spectrum.

Q. So that sixteen of Ferrari's can be accounted for by—

A. This.

Q. —this?

A. Yes..

*Re-cross-examination.*

By MR. WHITCOMB:

Q. Then you are now testifying he did not have the oxalate lines. Is that right?



A. I am testifying that there are lines corresponding to yellow PbO in the Ferrari pattern, and they may correspond to other lines in other materials.

Q. The very same lines?

A. That is a possibility. Yes, sir. We have many samples of that.

Q. Then, of course, that does not exclude Dr. Clark's direct-examination and testimony that it may be Pb<sub>2</sub>O, does it, or suboxide?

A. Unfortunately, I have never seen any lead suboxide or obtained any diffraction pattern or lead suboxide, so I cannot answer your question.

Q. Then your answer is you don't know?

A. I don't know.

MR. MORRIS: That's all, Dr. Anderson. Thank you.

(Discussion off the record.)

MR. MORRIS: Dr. Davey is recalled.

WHEELER P. DAVEY, recalled.

*Re-direct-examination.*

By MR. MORRIS:

Q. Dr. Davey, will you take the stand, please?

A. Yes.

MR. MORRIS: I offer in evidence the films of Dr. Davey, made by Dr. Davey, of Electric Storage Battery Company gray oxide, the numbers of which are marked on this box. I offer the box and its contents as the Defendant's Exhibit 157.

(Box of films marked as Defendant's Exhibit No. 157.)

MR. MORRIS: The second box, with like contents but different films, the numbers of which are marked on the box, I offer as 158.

(Box of films marked as Defendant's Exhibit 158.)

By MR. MORRIS:

Q. What films are these in the box that I now hand you?

A. These are diffraction patterns taken in connection with the work at the Electric Storage Battery Company in order to obtain a knowledge for this hearing.

Q. They are just additional films of the same kind?

A. All four boxes contain films.

MR. MORRIS: I offer this box and contents as 159, and I offer this box and its contents as 160.

(Two boxes of films marked Defendant's Exhibits Nos. 159 and 160, respectively.)

By MR. MORRIS:

Q. Dr. Davey,—

A. Yes.

Q. —have you any book showing the diffraction pattern for lead carbonate?

A. I have.

Q. Will you produce them?

A. I have here a book, the second edition of Wyckoff's book, entitled "The Structure of Crystals", published by The Chemical Catalogue Company. On page 274 are listed the fundamental data for  $\text{PbCO}_3$ . It is listed as being orthorhombic in structure with three lattice parameters, 5.14 Angstroms, 6.10 Angstroms, and 8.45 Angstroms. The data are taken from an ar-

icle by W. H. Zachariasen, published in a Norwegian book, called "Skrifter Norske Vindenskaps—Akad. Oslo I. Mat.—Naturv. Klasse", in 1928, No. 4.

Q. Do you find that any—

THE COURT: Let me see that book.

THE WITNESS: Yes. That's the one that is marked there.

Q. Have you another book in which you find the measurements of the diffraction patterns for lead carbonate?

A. No. I have a book containing a semi-log and charts, by which the match between the theoretical patterns may be obtained—between the theoretical patterns and the experimental patterns may be obtained.

Q. All right. Will you tell us what this discloses?

A. I have written on the margin of this sheet certain lines on a logarithmic scale going with the chart on page 612 of my book. Those lines correspond, as accurately as can be made with pencil, with the diffraction pattern for Professor Clark's highest accuracy lines for his so-called  $Pb_2O$ .

From Zachariasen's data I can deduce that if we use the lattice parameter 6.10 as our reference parameter, we get axial ratios of 8.4 is to 1 is to 1.4, which is approximately the same as shown on the chart on page 612 of my book.

The chart on page 612 differs only in that it is for axial ratios of A is to 1 is to 1.4 instead of 1.8. I think I am correct—yes, I am correct. If, on that chart, I try to superimpose the lines of Professor Clark's pattern of highest accuracy on the axial ratio of 8.4 on the chart, I find a very nice and interesting match.

Now, I should emphasize in this that we are in the position of a fingerprint expert who has a portion of a fingerprint with which to identify his so-called crim-

inal. If he has a portion of a fingerprint, of course, he can't expect to prove that he has identified a particular man, but he can say that it is this man or that man or this other man, because you can limit the identification to those men for whom the corresponding portion of the fingerprint matches the print which he has in his possession.

And so it is not surprising that with what we might call a portion of a diffraction pattern of something called by Dr. Clark  $Pb_2O$  we do not know what it is that we may be able to—it is the diffraction pattern—the diffraction pattern matches for that portion of a diffraction pattern with a great many other possible structures than the one which he has assigned within the same limits of precision that he has used in saying that his matches were the face-centered cubic type of pattern.

I have had a great deal of fun in going through some of these charts trying to find whatever it was, but this one for lead carbonate is especially interesting. I should like to start with the smallest interplaner spacing of Dr. Clark's measurements, and I can testify more directly in terms of the chart.

MR. WHITCOMB: Don't you think we ought to object on the ground that it is probative and has not weight because—

By MR. MORRIS:

Q. There is a correspondence of lines?

MR. WHITCOMB: —admittedly, only partially—being part of the lines?

(Discussion off the record.)

THE COURT: Is he going to testify a few of these lines that Dr. Clark found are matching lead carbonate?

MR. MORRIS: Yes, sir.

(Discussion off the record.)

THE COURT: Oh, I guess we might as well, but I don't know whether you are objecting or not. You asked me whether you ought to object.

MR. WHITCOMB: Yes, sir. I am objecting.

THE COURT: I suppose I ought to go over and look at it.

(Discussion off the record.)

THE WITNESS: Now, then, starting with the interplanary spacings which are the smallest, the 1.22 line comes at the place where several lines on the orthorhombic diffraction pattern have the same interplanary spacing. Therefore, there should be a great many planes contributing to the X-ray intensity at that particular diffracting angle, so we might expect an especially strong angle there. The next larger line of 1.25 comes at a place where—

By THE COURT:

Q. Is this the oxalate pattern down there?

A. Yes, sir. Clark's pattern.

Q. The oxalate is—

MR. MORRIS: The—it's carbonate.

THE COURT: I understand.

By THE COURT:

Q. But, what's the other thing?

A. The pattern is Clark's pattern listed as his highest accuracy lines for  $\text{Pb}_2\text{O}$ .

This 1.25 line also comes at the meeting place where several types of planes give the same type

of interplaner spacing and, therefore, might be expected to give a strong enough line to register, even in small quantities.

The 1.68 lines comes at the meeting place of about four lines and, therefore, might be strong enough to mention.

The 1.53 comes for a single line, and the 1.66 comes for a single line, of such a nature that it might be expected to be strong because of the particular layers of atoms it represents in the crystals.

Q. Does that mean—does that amount to your saying he had lead carbonate in that compound he analyzed?

A. It amounts to my saying this, your Honor: Two reputable scientists of the State of Pennsylvania do not find equal lines, and others in the State of Illinois finds the lines. Presumably, then, there is a difference between the two samples. I am not suggesting that that difference between the two samples might have been due to the presence of carbonate in Professor Clark's and the absence in Professor Anderson's and mine. It might be due to the absence of carbonate at the time we took our sample. Of course, that does not preclude the possibility of his, Professor Clark's, fundamental evidence from his decomposition of lead oxalate being lines composed of small amounts of undecomposed oxalate.

He has a partial fingerprint there which will match, so that he can have a basic set of  $Pb_2O$  lines from an oxalate experiment and another almost exactly corresponding to them from the oxide, the second one being from carbonate.

By MR. MORRIS:

Q. The substance so far of your testimony, then,

in regard to this matter is what? That he may have had—

A. That in his oxalate experiments he may have had some undecomposed oxalate, and that in his oxide experiments he may have had some lead carbonate.

MR. MORRIS: Cross-examine.

*Re-cross-examination.*

By MR. WHITCOMB:

Q. Dr. Davey, how long have you been working on these lead composition patterns?

A. Since approximately last New Year's.

Q. Approximately—how many years?

A. Since approximately last New Year's.

Q. That is about nine months or ten months?

A. Yes.

THE COURT: Do you mind letting me see your book, too, Doctor—

THE WITNESS: Certainly.

THE COURT: —when you are through with it?

THE WITNESS: Yes.

(Discussion off the record.)

By MR. WHITCOMB:

Q. Do you understand that you can distinguish between the lead oxalate line and the lead carbonate line?

A. If I had a complete diffraction pattern of lead carbonate and a complete diffraction pattern of lead oxalate, starting from the lines of the largest interplaner spacing and going a reasonable distance toward the smaller interplaner spacings, we could certainly



distinguish between the two; but, when you have a portion of a diffraction pattern, it is possible to make that portion of a diffraction pattern fit portions of several other theoretical patterns.

Q. And the same reasoning would apply, if Dr. Clark is correct, in his finding suboxide of lead; that is, in lead oxide less than—

A. He has never offered in evidence any evidence except his statement that it was  $Pb_2O$ . So far as I am concerned, we might as well call it a "What-is-it" or a "What-have-you". I am trying to help out by suggesting what this "What-is-it" or "What-have-you" might have been.

Q. In your last testimony, you are dealing with these few lines?

A. I am dealing with all the lines Dr. Clark submitted to the Court to the level of the highest accuracy. I am giving him every break I can.

Q. As far as the patterns you are comparing is concerned, you are—they are all lines on that pattern?

A. They are lines which the theoretical pattern would lead you to believe would be strong lines, so that if he had only a small amount of carbonate in the oxide product and, therefore, had strong lines of the carbonate in his diffraction pattern, he would still have a good match for what is supposed to be the strong lines for the theoretical pattern.

Q. As I understand your testimony, you attribute some lines to the yellow  $PbO$  and the red  $PbO$ , is that right?

A. I didn't say so, but it is perfectly true that if you wanted to you could get a great many coincidences. You could get some coincidences with the red  $PbO$ .

Q. Do you disagree with Dr. Anderson's testimony?

A. Not, as I remember it. Dr. Anderson said there were certain coincidences, and there are.

*Re-direct-examination.*

By MR. MORRIS:

Q. Mr. Davey, just a moment. Are you familiar with the standing and reputation of Le Blanc and Eberius in this field, or are you not?

A. They have a very good reputation.

Q. I am asking you that question with respect to the Defendant's Exhibit 153. Do you know the reputation and standing of Friche and Ackerman in this crystal field?

A. I don't believe that Friche and Ackerman are so well known, but as far as I know no fault has been found with their work.

Q. May I ask that same question with respect to van Arkel?

A. Van Arkel's work is very highly regarded by his fellow scientists.

Q. Darbyshire?

A. Same answer.

MR. MORRIS: That is all.

MR. WHITCOMB: Just a minute.

THE COURT: Do you want to go right ahead?

MR. MORRIS: Yes, sir, if that will suit your Honor. Maybe we can finish with the properties tonight, if it is convenient.

THE COURT: All right.

MR. WHITCOMB: That is all.

THE COURT: I want to just ask Dr. Davey one more question.

By THE COURT:

Q. Lead carbonate could be detected by an ordinary chemical analysis, couldn't it?

A. Yes, sir.

Q. Lead carbonate?

A. Oh, yes, provided you had enough of it there to come within a good quantitative analysis, you could.

Q. Dr. Clark testified, to subject it to a chemical analysis, you could not determine whether there was any lead carbonate there or not?

A. Provided you had enough of it there to make a microanalysis, you could.

Q. Micro-analysis?

A. Yes, micro-analysis, that's especially adapted for very small quantities of material.

Q. The point I am getting at is whether it would be possible to exclude your suggestion that these lines are lead carbonate by a chemical analysis of the sample?

A. I don't suppose he has enough of the sample he actually took the diffraction pattern of for a greater analysis. Of course, another sample from the mill, if it showed carbonate, would be fine, but—

Q. Well, how much does he have to have to show that?

A. He has testified that he finds about four per cent, I think, of this "What-is-it" in this Exide oxide. I assume, therefore, he would need something like twenty-five grams of material.

THE COURT: Well, he has that much left of the samples.

MR. WHITCOMB: Do you have that much left?

DR. CLARK: Yes.

MR. WHITCOMB: Yes.

THE WITNESS: Dr. Clark, himself being a

professional, chemical analyst, would be much more competent to tell you how much more material he would need to make a good analysis of the lead carbonate up to four per cent content.

THE COURT: All I wanted to know was if that suggestion you made—which I understand was not intended for more than a suggestion—that there might be lead carbonate in the mixture that would account for those lines could be either definitely proved or disproved by a chemical analysis.

THE WITNESS: I think it could, granted there was enough of the material.

By MR. MORRIS:

Q. Are you chemist enough to tell me whether the following might also be a sound hypothesis: Carbonate might have gotten in after the sample was opened and being tested in the laboratory of Dr. Clark?

A. It might.

THE COURT: It would still be there if it was in at the time—oh, you mean after he took it out of the tube?

MR. MORRIS: I don't mean and, of course, I want to disclaim any suggestion or inference from my suggestion that Dr. Clark put it in—

THE COURT: Sure!

MR. MORRIS: —but my opinion is that, on exposure to the air—and I intend to show that by Dr. Ullman—that the carbonate may form by the  $\text{Co}_2$  in the air. Now, as a consequence, in answer to your Honor's inquiry, it might be found or it might not be found, but the carbonate might have gotten in it during the handling of it.

THE COURT: Now, Judge, is it yours and Dr. Davey's combined position that this suggestion of his is capable of proof or—capable of being proved or disproved?

THE WITNESS: No.

• MR. MORRIS: No, sir.

THE COURT: I don't know which one to ask, but I am just wondering.

THE WITNESS: May I amplify my statement?

THE COURT: Yes.

THE WITNESS: That there is, evidently, a difference between Dr. Clark's material and my material. That difference may represent the presence of lead carbonate in Dr. Clark's material. We have no knowledge of the history of Dr. Clark's material. We don't know whether, by reason of accident, some of the sample—of the official sample—may have been taken which contained a little carbonate and another portion of the sample contained no carbonate, and one of us, by some strange quirk got the sample that was free from carbonate and his was not equally free from carbonate, or he had samples working in his laboratory and liberating an excess of carbon dioxide at the time he was preparing his specimens, and he might have made more carbonate in the laboratory than we did.

By THE COURT:

Q. Do you think your theory that you are now expounding is the best, really, to explain why Dr. Clark found what you didn't find?

A. It is a perfectly possible and plausible theory.

Q. Well, have you any better theory? We can, of course, assume, when you start out—otherwise, you must start with the proposition he didn't find the lines he said he did.

A. I didn't suggest that. Professor Clark is a reputable man.

Q. Well, if he found certain lines, there must be some explanation of it. Now, the suggestion you are making, now, is that the sample he analyzed is different from the one you analyzed?

A. That it contained an impurity which ours did not contain.

By MR. MORRIS:

Q. I direct your attention to the centrifuge and the petroleum, or whatever it was, that was used in that machine, together with the use of that machine. Are you enough of a chemist to know whether there is a possibility there of getting some carbonates in your product?

A. I can answer your question in two ways. It is well known in the electrical industry that gases are quite soluble in oils. There may, therefore, have been considerable gas contained in the petroleum or either the super centrifuge. Another possibility is that with the process which Dr. Clark has described for getting the oil off his specimen afterwards, that he might have left a thin skin of oil on the particles which he has taken out. That thin skin would not necessarily have to be more than a molecule thick, but it would oxidize quite readily under certain conditions, and it might very easily give a source of carbonate.

THE COURT: All right.

By MR. MORRIS:

Q. Is there any more assurance that it is  $Pb_2O$  than it is lead carbonate?

A. To me, it seems much less reasonable—assigning a new type of chemical compound, violating all the principles—than to say it is lead carbonate.

Q. If you say it is  $Pb_2O$ , it violates all the tables?

A. Yes.

MR. MORRIS: All right.

*Re-cross-examination.*

By MR. WHITCOMB:

Q. But you do not—you do know Dr. Clark made several samples and patterns that were not used in the super centrifuge machine at all, do you?

THE COURT: Sure, I know that.

THE WITNESS: Yes. But, if he used the super centrifuge machine, he got strong lines.

THE COURT: Oh, yes; No. 6 wasn't from a centrifuge.

MR. MORRIS: Yes, but No. 6 is only one.

(Discussion off the record.)

MR. MORRIS: The only measurements that we have or was able to get of the measurements—are the measurements of Dr. Davey and Dr. Anderson—and the only measurements we have of any samples in the world that Dr. Clark has ever made, they are, and he has told us he has given us all—was Nos. 6 and 10.

THE COURT: No. 6 wasn't the centrifuge.



(Discussion off the record.)

MR. MORRIS: As far as we know, there has been no measurement because we have all of Dr. Clark's measurements. He has had only two samples that he has measured, and one is No. 6 and one is No. 10, and that is out of all six or eight test tubes full.

(Discussion off the record.)

THE WITNESS: Your Honor, may I clarify the point you brought up?

THE COURT: Yes.

THE WITNESS: No. 6 contained a very small quantity or amount of this "What-is-it" as evidenced by the weakness of the lines as ascribed to the "What-is-it". The super centrifuge obtained lines of much greater intensity, and I am trying to help out Dr. Clark by saying it is quite conceivable that the oxidation of a residual film of oil might have produced this same lead carbonate.

THE COURT: All right.

MR. MORRIS: Now, Dr. Ewing, please.

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WARREN W. EWING, was called as an expert witness on behalf of defendant and having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

My present position is Associate Professor of

Physical Chemistry at Lehigh University. I have occupied that position for fifteen years. The experience and training that qualified me for that position was as follows: Doctor of Philosophy degree at the University of Chicago; two summers of work at the New Jersey Zinc Company, in the study of absorption and particle size. And I have been serving as referee on articles for the Journal of the American Chemical Society for four or five years. By referee I mean that when an article is submitted to the editor of the Journal he sends it to some referee to give an opinion as to whether it is worthy of publication in the Journal or not. I serve as one of those referees. In collaboration with Dr. Ullmann I have done some work in connection with the case now before this Court. I have formed a conclusion as to whether  $Pb_2O$  does or does not exist. My personal opinion is that it does not exist.

Q. Now, then, will you state your reasons why you arrive at that conclusion?

A. Would it be permissible if I refer to some notes that I have?

THE COURT: Yes, you can do anything you want.

THE WITNESS: I think I could get this out of the way faster. I have listed some evidence which I think is worthy to bring to the attention of the Court. The first I have listed is a chemical evidence dealing with this matter of so-called suboxide.

If lead suboxide exists, the lead would have to have a valence of one in  $Pb_2O$ , and that is contrary to its position in the periodic system, which is one of the oldest and most reliable of the chemical laws which we have.

Q. Will you explain, for the record, briefly, what you mean by valence?

A. Valence is sometimes called the combining power of an element; that is, a substance having a positive one valence will combine with a substance, sodium, having a positive one, chloride, forming sodium-chloride.

Q. Will you proceed from there, Dr. Ewing?

A. Now, if we assume that lead has a valence of one in this compound,  $\text{Pb}_2\text{O}$ , and we treat the compound with acetic acid, and the acetate has a valence of one, we should get a lead mono acetate. Lead suboxide is reputed to dissolve in acetic acid but we get no lead mono acetate, and even Dr. Clark in his testimony doubted the existence of such a compound, although he said that references had been made to it in the literature. Personally, I have never seen any such references made. The usual method for writing this reaction in the literature is that one molecule of lead suboxide reacts with two molecules of acetic acid to give one molecule of lead acetate, one atom of lead and one molecule of water.

Q. I wonder if it would help, Dr. Ewing, if you would use a crayon on a sheet of paper?

A. I will be glad to.

(Witness writing symbols on paper exhibit.)

THE WITNESS: You will find that referred to in various articles on—

THE COURT: They all assume the existence of lead suboxide?

THE WITNESS: Yes. This is for reactions which do assume the existence of lead suboxide.

(Discussion off the record.)

THE WITNESS: That gives a balanced action, all right, so we can account for every atom over here by the same number of atoms over there, but we find that we have here two lead atoms which—of which are mono valent.

We find that down in this compound we have a lead compound which is tri valent; that is, it is hitched up to two of these valences, giving us lead acetate. We find here a free lead atom, which has no valence. In other words, this mono valent lead atom has changed to this di valent—that should be di valent—atom, and another one of these mono lead atoms has changed to a neutral lead atom. The valence of one has increased; the other decreased. We say that one of them has been oxidized and the other reduced. Acetic acid is neither an oxidizing nor a reducing agent, so that we would have to assume, in this compound, we have an internal oxidation, oxidation reduction, in the metallic element.

MR. MORRIS: I offer that in evidence as the Defendant's Exhibit 162.

(Paper marked Defendant's Exhibit No. 162.)

THE WITNESS: I have another reaction which I want to follow. Should I write that on there, or should I wait?

By MR. MORRIS:

Q. You may proceed, Dr. Ewing.


A. Dr. Clark gave us the equation for this reaction in which he dissolved the so-called lead oxide in acetic acid.

Q. Will you draw a line—

A. That's right.

Q. —underneath that, and then will you proceed?

A. (After doing so) His equation was that  $\text{Pb}_2\text{O}$  plus four acetic acid gives two lead acetates plus two water. He neglected to balance the equation, but undoubtedly he meant to put in an oxygen molecule here (indicating) because he said it took place in an oxidizing atmosphere.

Q. That is, you have added an 02 right ahead  right behind the flight of the arrow?

A. Yes. Dr. Clark didn't put that in, but he mentioned it.

Q. Do you want to close your parenthesis?

A. All right.

Q. Will you examine your last equation and see whether that 02 you have inserted in the arrow's flight should be 20?

A. This is Dr. Clark's equation. I wish he would tell you that.

DR. CLARK: 01.

(Discussion off the record.)

By MR. MORRIS:

Q. Will you proceed, please?

A. Acetic acid is neither an oxidizing nor a reducing agent, as I have said. Therefore, the reaction could only be explained by internal oxidation-reduction between the lead atoms, because no other such internal oxidation-reduction is known between the metallic elements.

Now, that assume that in the acetic acid that oxygen is dissolved; that such a reaction of that, if lead suboxide exists, would be possible; but the objection to the reaction, as I recall Dr. Clark's de-

scription of it is he said part of this material dissolved quickly and part of it dissolved very slowly.

Now, if that is a true representation of the reaction, I see no reason why the reaction should not go ahead rapidly because this reputed— $\text{Pb}_2\text{O}$  is reputed to react very quickly with acetic acid; that it is a very reactive substance, especially in the water—although we have only  $\text{H}_2\text{O}$  represented, the acetic acid is a solution where we have a large quantity of excess water—probably ninety per cent. or maybe ninety-five. We usually use about fifty per cent. acetic acid in these experiments, but there is a large amount of water. That's when the acetic reaction—I mean, in the acetic reaction and the lead suboxide—and when the water reacts with the lead suboxide.

The only way I can account for the slow reaction is that you would have to go back to the first reaction, in which you get metallic lead, and that, of course, would react only very slowly with the acetic acid in the presence of oxygen; and, if we do that, we are in the same predicament that we were when we attempt to use the first reaction in explaining the disappearance of lead suboxide.

The other explanation I might offer there is he said there was a certain amount of impurities there, which dissolved, as I understood him, very slowly but eventually did dissolve. And lead suboxide should contain, theoretically, 96.3 per cent. lead. His compound analyzed 95.88 per cent. lead, which left room for only four-tenths of one per cent. impurity. That's four-tenths of one per cent., of one-tenth of a gram, and is four-ten-thousandths of a gram—four-tenths of a gram in impurity. Four-ten-thousandths of a gram impurity in a substance as dense as lead suboxide, in a certain volume of acetic acid, would be hardly perceptible. It is just about the limits of

weighing in the ordinary analytical balance, the limit there being about two-ten-thousandths.

Another line of evidence which I might suggest, which leads me to conclude that lead suboxide does not exist, is the density determinations. Under Dr. Ullmann's supervision, in our laboratories, density measurements have been carried out on the Exide oxide, and these density measurements have been compared with the density calculated for that same mixture of lead and lead oxide that is—that is, red lead oxide. These two values check, and that is the value of the analyzed—well, let me put it this way:

Suppose the gray oxide analyzes fifty per cent. lead, or half lead—by percentage, I mean molecular percentage—fifty per cent. lead and fifty per cent. lead oxide which has a certain density as measured. Then, looking in the literature, we know the density of lead and we know the density of lead oxide, and we calculate what the density of that mixture should be.

Well, in our laboratory, these two values checked, showing that there is not room—there is no room for more than an infinitesimal—not infinitesimal but small traces of any impurities in these two substances.

Q. What two substances?

A. Lead and red lead oxide.

By THE COURT:

Q. Can you take a sample and, by chemical analysis, tell that there is nothing there except lead and lead oxide?

A. I don't think of any direct chemical method, but my next point here was a method which verges on the chemical, and that's the next evidence which I want to present, and that's the amalgamation evidence.



Q. Maybe I am using chemical in a narrower sense than you would use it. Go ahead.

A. Well, amalgamation means the dissolving of lead in mercury, but usually we don't speak of them as a strict chemical action itself.

By MR. MORRIS:

Q. What is your density?

A. That is purely physical.

Q. That is purely physical?

A. Yes, sir.

Q. That establishes what?

A. That establishes that the gray oxide must be made up of a mixture of red lead oxide and lead.

Q. Now, you are passing to another test, namely, the amalgamation evidence, which you said is relating to the chemical test?

A. Yes.

Q. Will you proceed with that?

A. Lead dissolves in mercury, if you can get good contact between the lead and the mercury, although Berzelius said he based his evidence that he had suboxide on the fact that it would not amalgamate with mercury, and, therefore no free lead was present.

And it took such a genius as Dr. Ullmann, of Lehigh University, to prove that Berzelius was wrong there. He has shown that when these gray oxides are treated with mercury in the correct manner—and I believe that Dr. Ullmann is going to be on the stand to give his experimental detail.

THE COURT: Well, now, don't repeat it. I do protest. Don't both of you talk about the same experiments. If Dr. Ullmann is going to talk about this, don't you do it. Let's save time.

THE WITNESS: Well, I will make it brief, then,

by saying that I consider Dr. Ullmann's test a very strong test to show that there is no gray oxide in the suboxide, and I will have to make the same remark about another test which Dr. Ullmann is going to testify to, and that is concerning the heats of reaction. I consider that Dr. Ullmann's heat of reaction experiment is even a stronger test than the amalgamation.

By THE COURT:

Q. Did you collaborate with him in those experiments?

A. In the heat of reaction experiments, I have given him and his assistants advice because I have been working on heats of reactions for many years.

Q. The other one, you did not?

A. The other one, I did not, no.

Q. All right.

A. And I consider that his heat of reaction experiment shows conclusively—

MR. BETTS: Your Honor, may we have stricken out from the testimony about what Dr. Ullmann did when this witness did not collaborate with him?

THE COURT: Oh, yes, I think so. I don't see why—except I will let his opinion stand that that is a good test, but that is all.

MR. MORRIS: We are not offering by this witness the mercury test or the heat of reaction test, although I understand he did collaborate with Dr. Ullmann in the heat of reaction to some extent.

THE COURT: Yes.

MR. MORRIS: But the question is on what he bases his conclusion that  $Pb_2O$  does not exist.

Now, then, if I don't prove this fact by Dr. Ullmann, of course, it should go out.

THE COURT: I will let it stand, as far as it goes.

(Discussion off the record.)

By MR. MORRIS:

Q. Will you proceed, Dr. Ewing?

A. I consider, then, that the heat of reaction experiment offers conclusive evidence that the gray oxide—that is, the Exide oxide—does not contain—well, I don't like that word infinitesimal—an amount but approaching an infinitesimal amount of lead suboxide.

Infinitesimal, to my mind, means none at all. It approaches it, but we might say ten times an infinitesimal amount. In other words, ten times nothing at all. A very small amount is the word I want to use, I guess.

By THE COURT:

Q. That's the most that could be there?

A. Yes.

By MR. MORRIS:

Q. Of what?

A. Suboxide in the gray oxide. That's the most suboxide that could be present in the gray oxide.

Q. Do you mean by that that you recognize the existence of gray oxide or assume it?

A. No, assume. When I say gray oxide, I assumed it, because when I started, I said, I did not believe in it.

Q. All right. Will you proceed?

A. Of course, then, there is an X-ray evidence, but I am not an X-ray expert.

THE COURT: Well, now, you can't answer that question then, and that was what I was interested in. If you get a substance and you put it through all your tests, including Dr. Ullmann's tests, and you are absolutely satisfied yourself—one hundred per cent.—so that it is strong enough to hang a man in your opinion—is it your opinion that there was nothing in that substance by lead and some oxide of lead. Then you put it through the X-ray test and it shows the lines that are not the lines of ordinary lead or lead oxide, it does not follow, necessarily, that those lines must be the lines of some oxide other than PbO? Of course, I asked Dr. Davey that question and he didn't want to answer it because he is not a chemist and you don't because you are not an X-ray expert.

THE WITNESS: I don't think it requires an X-ray expert to answer that question.

THE COURT: All right. Let's have it.

THE WITNESS: The answer to that question is that if the product has been analyzed to show that there is nothing else but lead and oxygen present, then your examination is right. The extra lines must mean something other than oxide of lead, but it tells you nothing about what other oxide of lead is present, as far as I can see it, unless all other oxides are known and identified.

THE COURT: Sure. That's all I expect.

THE WITNESS: You might just as well as-

sume that  $Pb_2O$  is  $Pb_{819}$  as far as I am concerned.

THE COURT: Yes. Now, let's leave out the physical test. You can tell by a chemical test, as I understand it, that the composition contains nothing but lead and oxygen. Can you go that far? Can you tell that, with absolute certainty, by you chemical tests?

THE WITNESS: To require—to tell that, with absolute certainty, that would require an extremely accurate experiment work, such as involved in determining atomic values.

THE COURT: Do you think you could do it?

THE WITNESS: I could not.

THE COURT: Do you think it could be done?

THE WITNESS: Yes.

(Discussion off the record.)

By THE COURT:

Q. You could limit yourself to lead and oxygen, those two elements?

A. Yes.

Q. But you could not, by a chemical test, limit yourself to lead and oxygen—that's lead and oxide—limit yourself to lead and oxide,  $PbO$ ?

A. In a commercial product, you very seldom have a product which is pure enough to justify an analysis of that type.

Q. Yes. Another thing you couldn't do, chemically is to identify a particular suboxide of lead present?

A. No.

Q. You couldn't go any further than to satisfy yourself that the substance you have, or the mixture you have, is lead and oxygen, as I understand it? You could do that, at least?

A. To a fair degree of accuracy.

Q. But you couldn't chemically satisfy yourself, even to that extent, what particular oxide of lead it was that was present?

A. No, because we can't purify the material to find out its properties.

Q. All right.

A. Before you analyze it, you have to know its properties.

Q. Well, but you know the properties of  $PbO$ ?

A. Yes.

Q. Well, that's what I mean. I say, I don't believe you understood me, quite.

A. I understood you. You asked if we could analyze of all the compounds of lead or all the oxides which are present?

Q. Yes, that's about what I wanted to know.

A. Yes.

Q. In other words, the answer is?

A. The answer is I could not.

Q. Yes. In other words, if I give you a mixture—I don't know how accurately this is put—but a mixture, one-quarter lead, one-quarter  $PbO$ , and one-quarter  $PbO_2$ , and the other quarter sesquioxide—or whatever it is—all you could tell me about that mixture is it was lead and oxygen?

A. Chemically, yes.

(Discussion off the record.)

MR. MORRIS: You may proceed, Dr. Ewing.

THE WITNESS: I wonder if I could qualify that answer?

THE COURT: Well, just wait a minute while we change stenographers.

By MR. MORRIS:

Q. You inquired whether you might qualify that answer. What qualification have you in mind?

A. This is a supposition, the qualification—suppose that your mixture contained two oxides and lead, and I happen to know a test for that oxide, and I happen to know a test for that oxide, and I happen to know a test for lead; why, then I could analyze it.

THE COURT: Well, but—

THE WITNESS: But I don't know my chemistry of lead well enough to know whether I could give you specific tests for any two oxides and pure lead.

THE COURT: Doesn't anybody know that?

MR. MORRIS: Perhaps Dr. Ullmann can answer that question.

THE WITNESS: He might, but unless you did know the test for the particular substances my first answer stands.

MR. WHITCOMB: Well, let me see, then, we ought to have of record whether this is a chemical expert or what expert is this?

THE WITNESS: Physical chemistry.

MR. WHITCOMB: Physical?

By MR. MORRIS:

Q. Now, will you turn to your microscopic evidence, if you are through with the other?

A. Yes, sir. My personal investigation—



THE COURT: I always seem to get hold of the wrong man to ask my questions. They are more fugitive than the substance we are after, I guess.

THE WITNESS: My personal work with these oxides has been mostly with the microscope.

THE COURT: Yes, well, all right.

THE WITNESS: And I wanted—

MR. WHITCOMB: Of course, you must remember he drew all that on the chart.

THE COURT: I know.

MR. WHITCOMB: He tells about all those; one minute they are, one minute they are not.

THE WITNESS: That is freshman chemistry. The Judge is asking for graduate chemistry.

THE COURT: No, I am asking for sub-freshman chemistry.

THE WITNESS: No, you are way up in the graduate work, because if this were an easy question there would be no trial.

THE COURT: Well, I don't know.

THE WITNESS: I was given various samples of these oxides and asked to determine what the—what kind of particles went into the making up of these oxides, and the first experiment which I carried out was to make photomicrographs, magnification 1800 times, of an Exide oxide, one of the official samples, and Toronto oxide, and oxalate oxide, and various others.

THE COURT: Now, were those photomicrographs, were those photomicrographs that you had?

MR. WHITCOMB: Yes.

THE COURT: All right.

MR. WHITCOMB: We put some in.

THE WITNESS: How many of these do you want discussed? I have Toronto oxide, Exide oxide—

By MR. MORRIS:

Q. Why not just discuss the Exide and the Toronto? Have you that exhibit with the—

MR. YAMAOKA: 24.

MR. MORRIS: Just a minute, I want to refer you, I want your photomicrograph.

All right, proceed, Doctor, we will come to that later.

MR. WHITCOMB: 27.

THE WITNESS: Do you want the Exide Oxide?

MR. MORRIS: Yes.

THE COURT: I wonder if we are really going to get started on this? Don't you think we better let this go until tomorrow morning?

MR. MORRIS: Just as you like. It won't take much longer to finish it. I am wrong, if Your Honor please, it will take him much longer than six o'clock to finish.

THE COURT: Well, maybe possibly during recess you may see some things you can cut down a little on.

MR. MORRIS: We won't, if Your Honor please, we have cut this down to the bone already, and we have cut and cut until we cannot—

THE COURT: All right.

MR. MORRIS: —cut any more. Is it Your Honor's pleasure to stop now?

THE COURT: Well, I don't want to cut right in the middle.

MR. MORRIS: No, this is a new reason, and this is the particular field in which Dr. Ewing has done much work, and it will take quite a little while on this particular reason, will it not, Dr. Ewing?

THE WITNESS: Oh, probably twenty minutes.

MR. WHITCOMB: Do you want to go to quarter of six?

THE COURT: All right, go ahead for a while yet.

MR. MORRIS: All right.

By MR. MORRIS:

Q. I hand you a copy of Dr. Clark's Exhibit number 27. I think this is my copy and not the official exhibit, but you may use that in connection with your reply here if you so desire.

A. I find in this particular examination at 1800 magnification the substance seems to be composed of two types of particles.

By THE COURT:

Q. Big and little?

A. Large particles and small particles, the small particles ranging in size from a tenth to five-tenths of a micron, and the large particles of such variation in size that it is difficult to get a representative sample under the microscope.

I find these same conditions exist with the Toronto oxide and with the oxalate oxide, the Toronto oxide very evidently having a smaller average particle size, that is, there are very few of them up to five-tenths of a micron; the oxalate oxide having particles apparently slightly larger than the Toronto oxide, although that is doubtful.

By THE COURT:

Q. Well, now the point of this is that you did not find these semi-transparent—

A. Not in—

Q. — lumps that Dr. Clark found?

A. Not in this particular set of experiments, but later on I did find particles very similar to those, and perhaps it would be a good idea to bring that point up next.

By MR. MORRIS:

Q. Now, when you have prints that you want me to put in evidence may I have them? I have a set of three here. Are they copies—

A. They are copies.

Q. — one of the other, and they are what, and they show what?

A. On the back, mill number 3, screen product.

Q. 1800 magnification?

A. Yes.

MR. MORRIS: I offer one of those in evidence as Defendant's Exhibit 163.

(Photograph entitled "Mill #3, Screen Product, 1800 X, W. W. Ewing" was marked Defendant's Exhibit number 163.)

By MR. MORRIS:

Q. What is this that I now have in my hand, Dr. Ewing?

A. Oxalate oxide, 1800 X, sample supplied by Dr. Ullmann.

MR. MORRIS: I offer that in evidence as Defendant's Exhibit 164.

(Photograph entitled "Oxalate Oxide P. 338, 1800 X, W. W. Ewing" was marked Defendant's Exhibit number 164.)

By MR. MORRIS:

Q. Then the next, what I now have, is what?

A. It was supplied to me as 1916 oxide, Toronto pipe sample.

Q. The pipe sample from Toronto. Where did you get it?

A. Dr. Ullmann supplied it to me.

Q. Dr. Ullmann, all right, I will bring that out from him.

A. I think I can, maybe I can give you—

MR. WHITCOMB: Do we understand that this was obtained in 1916?

MR. MORRIS: No.

THE WITNESS: No, the label on that was 1916 oxide, January 11, 1933, 12.24 P. M., Willard Storage Battery, Toronto, Canada, pipe sample, signed G. H. W.

MR. MORRIS: Now, then, let's leave off, may I with your approval, Toronto pipe sample, and leave off the 1916 oxide?

THE WITNESS: All right.

MR. MORRIS: That is Defendant's Exhibit 165.

(Photograph entitled "Toronto Pipe Sample, 1800 X, W. W. Ewing" was marked Defendant's Exhibit number 165.)

THE WITNESS: May I go ahead.

By MR. MORRIS:

Q. All right, have you got any more?

A. After receiving, or after seeing the Plaintiffs' Exhibit number 27 I went back to the laboratory and took a sample of mill number 3, run number 25, and so forth, and so forth, official sample, took a small amount of that and placed it on the microscope slide, and placed some Nujol containing a five-tenths per cent. lecithin, which is a good dispersing agent, to get the material all separated, placed it under a microscope, and by moving the field back and forth here made some fifteen hundred field examinations, and in doing that I ran across several crystals which to me seemed to be very similar to the ones described by Dr. Clark, of which I made line drawings, which were also examined in our laboratory by Mr. Serfass.

By THE COURT:

Q. Which was that, the Exide oxide?

A. That is the Exide oxide.

Q. Yes.

A. And I have drawn line drawings of these crystals which show up. I examined these crystals under polarized light. I found some of them were isotropic and some of them anisotropic. When I compared them with the known sample of red lead oxide they seemed to be exactly similar in color and general appearance, and the explanation that some of them are

anisotropic and some isotropic could be that the tetragonal structure is such that when it is mounted on one plane it is anisotropic, on another plane it is isotropic.

I have the various line drawings of these crystals.

Still thinking that it might be the suboxide, I thought it would be advisable to place them in water instead of Nujol, so I dispersed them in water on the slide and made exactly similar study, and found approximately the same number of these crystals. I find, I averaged up for several hundred runs and I found I was getting about one crystal to every twenty-five fields that I examined, so that I estimated their quantity must be less than one-tenth per cent. and probably less than that, even, and I found in the water similar crystals, some isotropic and some anisotropic, similar in appearance to the red lead oxide.

By MR. MORRIS:

Q. Well, now, what deduction do you make from the fact that you found the same or similar crystals unchanged when you treated them with water, as to those crystals being  $Pb_2O$ ?

A. I drew the conclusion that they could not be the assumed  $Pb_2O$  if it has the properties which have been assumed for it, namely, that it reacts very quickly with water.

Q. You did or did not find—you answered that; you may proceed.

A. Another study which I made was to take the oxide without dispersing it. I neglected to mention, perhaps, that in these 1800 magnifications the particles had been dispersed by a special process which is in use among particle size experts. It is not worth while, I believe, to—it is the Haslam and Hall process.



Q. Do you have any pictures, photographs, there of what you just testified to about these crystals?

A. Only in my line drawings in my notebook.

Q. Very well. Those crystals were similar, as I understand, in appearance to those illustrated or shown in Plaintiffs' Exhibit 27?

A. Yes, sir. That similarity in appearance does not identify them, however, as the same crystals, but I merely want to make the point that those were the only crystals—

Q. Just a moment,—

A. — I could locate of anywheres near the same nature in some two thousand examinations.

Q. You referred to water a moment ago, to which you subjected these crystals shown in Plaintiffs' Exhibit 27. Any air present?

A. Oh, yes, ordinary distilled water always has air in it.

Q. Yes, but done in the open air in the room, or not?

A. Yes, the water was allowed to evaporate off, leaving the dry powder nicely—well, not too nicely dispersed, but nicely enough dispersed so that it could be examined.

Q. Did any change—

A. No cover glass; out in the open air.

Q. And what change took place, if any?

A. None.

Q. All right, proceed.

A. The next examination which I made was to see just what the nature of the gray oxide is, as far as the microscope would tell, that is, without dispersing it, and so I placed this material on a cover glass by a special technique, I cemented it on with de Khotinski's cement, so that the slides could be

moved about without it dropping off, that is, the de Khotinski's cement did not touch anything but the bottom of the particles, leaving the rest of the particle free, as though no cement were there, and I have samples of some nine different oxides treated in this manner, and I have attempted to color these to show more clearly exactly what they look like.

This color is not very good, I am not an artist, it should be, as near as I can tell, that color (indicating). I colored only a few of them. They all should be colored.

Q. Now, these are photographs of what, Dr. Ewing?

A. Well, this is Toronto oxide. It is too green. It has a greenish appearance in general, but—

Q. What magnification?

A. 60.

Q. 60 magnification?

A. Yes.

Q. Let's take off "1916 oxide" and call it Toronto.

A. All right. 1916 is what was on the label that was given to me.

MR. MORRIS: All right. I offer this in evidence as Defendant's Exhibit 166.

(Photograph produced by the witness Ewing, entitled "No. 1, 1/11/35, Willard Storage Battery, Toronto, Canada, J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 166.)

THE WITNESS: I have here a—

By MR. MORRIS:

Q. Will you pardon me just a moment?

A. Sure.

Q. Will you tell me what the Exhibit 166 purports to show, a Toronto oxide, but—

A. A Toronto oxide in which we have a large number of particles which have a greenish cast, and under the microscope in addition to that greenish cast you can also see bare particles of lead protruding here and there.

Q. Protruding through the green?

A. Through the green.

Q. All right.

A. That is, you can see metallic spots here and there all through it.

Q. What else did you do, Dr. Ewing, and why?

A. I treated these samples under the microscope—

Q. Which samples, the Toronto, or the gray oxide?

A. All of them.

Q. All right.

A. All of these oxides which I have presented photographs of I treated under the microscope with acetic acid, and as we watched, as I watched through the microscope I could see the acetic acid dissolve off the outer coating of yellow oxide, leaving chunks of lead.

Q. Referring now to the gray oxide which is represented in the photographs which I now have in my hand?

A. Yes, sir, and referring to those others, also. These are all gray oxides.

Q. Well, now, we don't need to put in any more than just one set of these, do we? Do we? What is the merit of the added ones, in particular?

A. These are collector's samples, this is bag collector's sample, Cyclone collector sample, mill one, run 20, and mill three.

Q. All right.

A. Some of them under the screen, some finished product.

Q. Let's lay these aside for the moment, or let me have them and let me number them tonight, so as not to delay now. Will you proceed?

A. If anyone cares to examine those I have here scales of the same magnification, which can be applied directly to these particles, and each division there is a hundredths of a millimeter.

Q. This measure you have given to Mr. Whitcomb, haven't you a copy of it?

A. Well, I have two copies, one of them probably should be on—do you want to make an exhibit of that, or not? It probably might be useful if anyone wanted to—

MR. MORRIS: I will offer the scale as Defendant's Exhibit number 167.

(Photograph entitled "Magnification, 60 X, W. W. Ewing" was marked Defendant's Exhibit number 167.)

By MR. MORRIS:

Q. Can you go on without my marking these photographs which I have in my hand?

A. Yes. I left off where I said I dissolved the yellow material off with acetic acid, leaving the chunks of lead. To confirm that those were chunks of lead I then placed silver nitrate on them, under the slide, and one could see the trees of silver growing, the typical reaction between lead and silver nitrate, to give silver and lead nitrate, with the lead gradually disappearing, and in its place a nice tree or bush of silver crystal. Scraped over with a needle point the lead had all disappeared, nothing but silver remained.

In order to find out something more about the nature of that lead which was under the oxide I dispersed the material in dry toluene, dried over sodium, containing four-tenths per cent. of lecithin, dried over  $P_2O_5$ , ran the mix through a colloid mill several times, and then separated the yellow fraction from the lead fraction, by decantation, and repeated the washing and decantation until eventually I had the lead fraction remaining, which did not seem to respond to any further treatment with toluene.

The sample which was obtained analyzed about, in one case, eighty-five per cent. lead, in another case, seventy-five per cent. lead. When we looked at it under the microscope practically no lead oxide could be seen running around there, but looking down into some of these larger crystals we could see that there were crevices which contained the yellow oxide.

I have here pictures of—this one I believe perhaps is not admissible because that is a commercial sample, but these two are official samples, or that one, two copies of it.

Q. Showing what?

A. The lead after it had been run through the colloid mill and the decantation process carried out. I then ran that.

MR. MORRIS: I offer this in evidence as Defendant's Exhibit 168.

(Photograph entitled "Mill #1, Run 20, Coarse lead fraction separated from oxide mixture in toluene containing 0.4% lecithin in colloid mill, W. W. Ewing" was marked Defendant's Exhibit 168.)

By MR. MORRIS:

Q. Did you say this is eighty-five per cent. lead?

A. That particular one is seventy-five.

Q. Do you know what the rest was, the major part of it, at least?

A. Lead oxide. I think probably this should go in that same exhibit. The difference between these two slides was this, that in this one—

Q. Which you have in your hand?

A. Yes, sir.

Mr. MORRIS: Which I offer as Defendant's Exhibit 169.

(Photograph entitled "Mill #1, Run #20. Fine lead fraction separated from oxide mixture in toluene containing 0.4% lecithin in colloid mill; W. W. Ewing" was marked Defendant's Exhibit number 169.)

A. (Continued)—I took the lead fraction and dusted it on to a slide, then tipped it over and knocked off what would knock off by tapping the back of it, and the last exhibit was the powder which still clung to the slide. That I termed a fine fraction. The heavy part which I could knock off went on to the other slide, and I have termed that a coarse fraction.

Now, if the Court wishes I can demonstrate in a minute or two the actual appearance of these materials under 60 magnification.

THE COURT: Well, we can wait a minute or two.

(The witness then demonstrated microscopic inspection of the slides.)

MR. MORRIS: You may proceed.

THE WITNESS: That finishes my microscopic testimony.

MR. MORRIS: That finishes your microscopic tests. From that you want to take up the equilibrium?

THE WITNESS: No, there was another microscopic test.

THE COURT: Well, it is six o'clock, I think we better conclude the entertainment, at this point.

MR. MORRIS: Well, I am still expecting and hoping to get through.

THE COURT: Tomorrow?

MR. MORRIS: Oh, yes, sir.

THE COURT: Well, all right.

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ELEVENTH DAY.

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Adjourned until Wednesday, October 9, 1935,  
at ten o'clock A. M.

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DEFENDANT'S EVIDENCE (Continued):

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MR. MORRIS: I offer in evidence, if Your Honor pleases, photographs referred to yesterday by Dr. Ewing, as Defendant's Exhibits 170 to 177, inclusive.

(Photograph entitled "Mill #3. Run #25, 6/21/34. Finished Product, J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 170.



Photograph entitled "Mill #3. Run #25. 6/2/34. Under Screen. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 171.

Photograph entitled Mill #3. Run #31. 8/3/34. Screen Product. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 172.

Photograph entitled "Mill #1. Run #21. 5/25/34. Finished Product. J. H. W., 60 X, W. W. Ewing" was marked Defendant's Exhibit number 173.

Photograph entitled "Mill #1. Run #20. 5/16/34. Under Screen. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 174.

Photograph entitled "Mill #1. Run #20. 5/16/34. Finished Product. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 175.

Photograph entitled "Cyclone Collector Sample. 12:15, 4/17/35. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 176.

Photograph entitled "Bag Collector Sample. 12:15, 4/17/35. J. H. W. 60 X, W. W. Ewing" was marked Defendant's Exhibit number 177.)

MR. MORRIS: I find that I overlooked yesterday in the mass of the exhibits the X-ray analysis of decomposition product of lead oxalate and the film which Dr. Anderson testified to, and I offer it as Defendant's Exhibit 178, and the film as 178-A.

(Two sheets entitled "X-ray Analysis of

Decomposition Product of Lead Oxalate" and sheet entitled "Interplanar Spacings of Decomposition Product of Lead Oxide" were marked Defendant's Exhibit number 178.

Film related to Defendant's Exhibit number 178 was marked Defendant's Exhibit number 178-A.)

WARREN W. EWING, recalled.

*Direct-examination (Continued).*

By MR. MORRIS:

Q. Dr. Ewing, you were testifying at the adjournment of court yesterday with respect to reasons which have led you to the conclusion that there is no  $Pb_2O$ . Have you taken in consideration in arriving at that conclusion the harmony and equilibrium testified to by Dr. Clark?

A. Yes, sir.

Q. What have you to say with respect thereto?

(Discussion off the record.)

By MR. MORRIS:

Q. Will you proceed, Dr. Ewing?

A. Dr. Clark in discussing harmony stated that there were eight different reactions which were proceeding in the mill, and that those reactions—

Q. Just a little louder, will you, please?

A. There are eight different reactions proceeding in the mill.

By THE COURT:

Q. Are those what he referred to as rates?

A. Yes.

Q. Eight different rates?

A. Eight different rates of reaction, or eight different rates proceeding in the mill.

The first of these, the rate of absorption, is a well-known rate that is agreed to, I believe, by all. That is, undoubtedly gases are absorbed on any solid surface to form a film.

His second rate was, the rate of the blast controls the thickness of the absorbed film. I don't know that I understand just what he means there by the thickness of the absorbed film, but if he is speaking in the ordinary terms used by the catalytic chemist I think we would have to disagree with him, that it is the rate of the blast which controls the thickness of the absorbed film. In absorption the gas goes on a surface according to the usual understanding in a mono-molecular film, and this mono-molecular film is formed very rapidly, probably a millionth of a second, in pressures of gas which are extremely small, down to limits which are barely measureable, and after that mono-molecular film is formed on the substance it may be that the film then begins to build up to a thicker film. If so, that undoubtedly is not conditioned upon the rate at which the gas passes over the solid, but is conditioned upon the pressure of the gas in the system, and that variation in pressure must be relatively very great. That is, the mono-molecular film is formed in the very rarefied gas, nowhere near atmospheric pressure, hundred thousands of an atmospheric pressure, and after you begin to build up pressure from that very rarefied condition you may possibly have a slight thickening of that film, but only with large relative increases in pressure.

Now, if Dr. Clark meant to say that the differ-

ence between the atmospheric pressure and the pressure existing in the mill, which I understand is a difference between fifteen pounds and seventeen and a half pounds, that relative change in pressure there should have practically no effect. If you change from fifteen pounds up to a hundred pounds it might be admitted that you had a very slight increase in the thickness of the film, but a small change in pressure from fifteen to seventeen would be insignificant.

As far as the rate of blast is concerned it could only be effective if there was a deficiency of gas present, and undoubtedly at atmospheric pressure, or at seventeen pounds pressure there is not a deficiency of gas, there is a very, very, very large excess.

By THE COURT:

Q. Well, I ask because it was not my understanding, and I am glad to get it now if it is correct, but was that Dr. Clark's view, that the rate of the blast affected the absorbed film?

A. That was my understanding of his words.

THE COURT: Was that what you intended to convey? If so, all right, and if not—

DR. CLARK: Well, the point there, Your Honor, is simply this, that experiments with catalysts indicate an optimum yield, that is, with certain rates—

THE COURT: Well, I didn't want to go into that with you,—

DR. CLARK: Yes.

THE COURT: —but all I wanted to do was to have you say either "yes" or "no", that Dr. Ewing has understood your view with regard

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to the increase, or the rate of the absorbed film. Has he understood it in what he has just said, or do you think he has misunderstood it?

DR. CLARK: Well, I think he is pretty close to the idea which I was trying to present.

THE COURT: All right, well, that is all I want to know.

THE WITNESS: That is on page 250 of the record.

THE COURT: I didn't catch that from your testimony, but I have it now. All right.

THE WITNESS: That is on page 250 of the record.

THE COURT: I knew that he spoke of the rate of increase of absorbed film, but I didn't know that he testified that the regulation of the blast had anything to do with it, but if he did, it is all right. All right.

THE WITNESS: The third rate was the rate of cooling by the air blast. I believe there is no discussion about that. That is a well-known fact. His fourth rate, the rate of chemical reaction of absorbed oxygen on lead to form lead suboxide; of course, that is a rate in which he has hypothesized an unknown substance, and the rate could be just as well explained by postulating a known substance, lead oxide, so that if in place of lead suboxide in that rate of chemical reaction of absorbed oxygen on lead we would substitute lead oxide, in place of lead suboxide, we could explain just as well how the reaction takes place. His fifth rate, the rate of diffusion of oxygen through the protecting outer layer of the lead



oxide is undoubtedly present, but my understanding is, that the claim for this substance is a very porous substance, so that that rate would be very small.

His sixth rate, the rate of removal by abrasion, of course, needs no comment. That is acceptable.

The seventh rate, the rate of dissociation of lead suboxide, here again, of course, he has hypothecated the existence of an unknown compound, and assumed that—assumed certain properties for this compound. One is that the rate of—the property which he has here assumed is that this lead suboxide must dissociate to give atomic lead and oxygen—no, atomic lead and lead oxide, red lead oxide. Of course, this is just merely a hypothesis of what the property of an unknown compound would be. If we should grant that this compound exists we would have to grant then that when it did break up according to this reaction we would have atomic lead present, and my understanding of one of the reasons for hypothecating this unknown substance is to show that we do have very fine lead in the product. Of course, if this supposed compound did break up to give atomic lead, this atomic lead would be present in an atmosphere of air, at a high temperature, I believe around one hundred and sixty to two hundred degrees centigrade, and it is a well-known fact, that even very small crystals of lead, not atomic lead, but small crystals of lead, containing many atoms, when tossed into the air at ordinary temperatures ignite spontaneously with the air to form oxides. If that is a well-known fact, therefore, it must follow that atomic lead in the presence of air at a high tem-



perature would ignite much more rapidly than small crystals of lead in air at room temperature. Consequently, this atomic lead which is formed must of necessity be entirely removed immediately to form lead oxide, and cannot remain in the product.

By MR. MORRIS:

Q. You say the atomic lead which is formed?

A. Yes.

Q. You mean that atomic lead is formed as a fact, or are you dealing—

A. I am dealing—

Q. — with a hypothesis?

A. I believe I made the remark that if we admitted that this substance were present that it must necessarily follow that atomic lead could not remain as metallic lead, but must be converted immediately into an oxide.

Q. I see, and you are still dealing with that hypothesis?

A. Yes.

Q. Very well, will you proceed?

A. I have some further confirmation of the fact that we cannot have extremely small—or that it is not necessary to postulate  $Pb_2O$  in order to account for extremely small lead particles in our product, or in the Exide products. Dr. Wilson in his report quoted Thomas' book on Colloid Chemistry, that it is well admitted that materials cannot be made in colloidal dimensions by ordinary grinding processes, and I believe that remark has also been made in this trial at some point. Svedberg, who is one of the most famous colloid chemists in the world, has written a book on Colloid Chemistry, in which I would like to read a paragraph. He says:

"Von Weimarn,"—another one of the very famous colloid chemists—"the Russian colloid chemist, suggested preparing dispersion systems by a special grinding method. His suggestion was to mix the substance to be dispersed with some neutral solid substance which would dissolve as a molecular solution in the dispersion medium and grind them together. He did not make any tests, but in my laboratory, Pihlblad used his method with rather good success. If we take sulphur and grind it with urea, 1 gram of sulfur + 1 gram urea, then take 1 gram of the mixture and mix it with 1 gram of pure urea, etc., making up a series of mixtures, and then dissolve a portion of those ground substances, we get a series of sulfur sols"—in other words, sulphur colloids—"with increased degree of dispersion. The sols were examined under the ultramicroscope and the change of light absorption with change in degree of dispersion was studied. Pihlblad also used this method to prepare colloid solutions of a dye stuff aniline blue and got a series of varying degree of dispersion. Quite recently v. Weimarn and his co-workers have used the procedure to prepare sols of various material taking sugar as the neutral diluting agent.";

showing that colloids can be made by grinding if you have special conditions, that is, the material to be ground and a neutral crystalline substance.

Q. Have you any such substance in defendant's mill?

A. Yes, sir.

Q. What?

A. You have lead and the neutral crystalline substance, lead oxide.

Furthermore, wondering if lead could not be made into colloidal dimensions, I picked as my neutral substance paper, and as my substance to be made into colloidal dimensions, lead. I carefully rubbed the lead substance with very fine emery paper, to remove any film of oxide on the surface, and then rubbed the lead over a large sheet of paper many times to remove any emery that might be on it, or any loosened surface, and then made a very light mark on a piece of the paper used in making copies in typewriting, so lightly that you could hardly detect that there was any mark present.

I then fastened that paper on a microscopic slide with balsam, using the usual technique, covered it over with balsam and a cover glass, placed it under a microscope, and I have here photographs of the results.

Q. And what do those photographs show?

A. Magnified one thousand times, magnification 1000 X.

MR. MORRIS: I offer it in evidence as Defendant's Exhibit 179.

(Photograph entitled "Photograph of a lead mark on paper magnified 1000 X, W. W. Ewing, E. J. Serfass" was marked Defendant's Exhibit number 179.)

THE WITNESS: The very fine points on there that look like very small blurs, if you examine it, you will find little pin points on there that just look like little blurs, in the general technique of particle size study at magnifications of this amount these small blurs are recognized as materials of colloidal dimensions, and the reason they are merely blurs rather than sharply de-

finer particles is that the particle is below the resolving power of the microscope. The resolving power of the microscope depends upon the wave length of light, and these are down so far below the wave length of light that they cannot be resolved by the microscope, no matter how much you magnify them.

The particles on there, those small particles, undoubtedly are no longer lead, but they undoubtedly were lead when the mark was made on the paper. That, however, would not change the size of the particle—the change from lead to lead oxide would not change the size of the particle; would not make it smaller at any rate.

Dr. Clark's final rate was the rate of oxidation of lead suboxide to lead oxide, and here I believe it is not necessary to say anything about this except that he has again postulated an unknown substance, for which there is—which it is not necessary to postulate in order to show that lead oxide is formed.

By THE COURT:

Q. Well, now, will you sum up your conclusions that you are drawing from this discussion of his eighth reactions?

A. To sum up my conclusions, I believe that it is not necessary to assume any lead suboxide to explain the harmony occurring in the mill, or to explain the fine rate—the fine state of subdivision of the lead, but that—but another harmony could just as well be built up without having to make assumptions which go against the recognized rules of chemistry.

By Mr. MORRIS:

Q. Have you anything further to add there, Dr. Ewing, in support of your conclusion that—

THE COURT: Well, now, just a line with that, as I understand it, though, Dr. Clark is not basing his testimony on a hypothesis, he is only using this matter that you have talked about, his reactions, to confirm an actual, physical fact which he says he has seen and touched. Now, am I right about that or wrong? Isn't that the point?

MR. WHITCOMB: Absolutely.

THE COURT: It is confirmatory of a physical fact which he testified to; namely, that he actually found lead suboxide in the samples. If I am wrong about that I have misunderstood everything that has been said since the case began.

MR. WHITCOMB: You are not wrong about that. That is exactly the point.

MR. MORRIS: If Your Honor please, let us assume that you are right, that Dr. Clark and the plaintiffs' main contention, ultimate contention, is, "I have it, here it is".

THE COURT: Yes.

MR. MORRIS: All right, but that is not where they begin nor, even if that is where they end, that is one of the factors which we have met and are still going further to meet. They might have brought in anything and labelled it  $Pb_2O$ . Indeed, Dr. Clark when he last went on the stand said, "I don't intend to confine myself, as did Shimadzu, to  $Pb_2O$ , I will take 2, 1 point, with a string of zeros",—

THE COURT: I remember.

MR. MORRIS: — and says that anything is suboxide.

THE COURT: Well, lead suboxide, let's substitute the word, lead suboxide.

MR. MORRIS: Yes, up to the ratio of one to one.

THE COURT: Yes.

MR. MORRIS: But this testimony of Dr. Ewing is addressed to those other things that were testified to by Dr. Clark. He is not the X-ray man, he is not the chemist, he is a physical chemist, and he is dealing with these things which Dr. Clark used to support his conclusion—

THE COURT: Surely.

MR. MORRIS: — that this substance that he brought in was  $Pb_2O$ .

THE COURT: Yes, I agree, I understand that, that is exactly what I had in mind, only the witness calls it a hypothesis all the way through, and it seems to me that where a witness, where a scientist has actually seen and felt the evidences of the presence of a substance it is not exactly a hypothesis.

MR. MORRIS: I wonder if it is not.

THE COURT: Well,—

MR. MORRIS: He christened it, he christened this substance suboxide without any justification whatsoever, so far as this evidence shows and will show when we are concluded.

THE COURT: Yes, I understand.

MR. MORRIS: Now, maybe that statement is a little too strong. There were lines which he found.

THE COURT: Yes.

MR. MORRIS: Every one of those lines except three have been accounted for by the presence, by Dr. Anderson, by the presence of  $PbO$  in its tetragonal and orthorhombic forms. Now, then, was the substance that he had  $Pb_2O$ ? What were the other three lines? I don't know, but all of his lines have been accounted for by the yellow  $PbO$  and the tetragonal form of lead. Now, then, he could go through the whole realm—

THE COURT: Well, I know, we may not be far apart, but it seems to me, to use a perfectly crude illustration, when a scientist in a criminal case examines the inwards of the deceased and finds a substance there, and he says, "In my opinion this is arsenic, because it shows certain reactions. I have certain reasons to say so". That is not a hypothesis, that is his definite opinion, and those are the reasons for his opinion. I would not call it a hypothesis. Now, he finds an unidentified substance there that a layman cannot identify. Now, he is asked what it is. He gives his reason for it. First, he finds the presence of something there that does not belong in the normal diet.

MR. MORRIS: Yes.

THE COURT: Then he proceeds to say what it is, and he supports that by certain reasons. Now, I wouldn't say that was a hypothesis. That was



the only thought; it may be it is just a matter of words.

MR. MORRIS: I think so. I don't want to add anything except this, of course, and it is really not worth adding, but in dealing with arsenic we have a known substance and there is nothing to postulate.

THE COURT: We only know it by its reactions. Nobody can look at what it is.

MR. MORRIS: That is true, but we have it isolated prior to that.

THE COURT: Oh, yes.

MR. MORRIS: Arsenic.

THE COURT: Surely.

MR. MORRIS: So to the extent that this has been christened suboxide without its ever having been isolated, and even yet tested chemically, is what I suspect Dr. Ewing means.

THE COURT: Well, I agree that it may be merely a matter of terminology.

THE WITNESS: I could carry your illustration just a little further.

THE COURT: All right.

THE WITNESS: Suppose the criminal died of poison and the doctor had examined the remains and found a poison there,—

THE COURT: Now, wait, do you mean the criminal died of poison?

THE WITNESS: Well, poison was found in the remains, anyhow.

Warren W. Ewing.

THE COURT: Of the deceased.

THE WITNESS: Yes.

THE COURT: You don't read enough detective stories, I am afraid.

THE WITNESS: And it is an entirely unknown poison.

THE COURT: All right.

THE WITNESS: It has never been heard of before.

THE COURT: Well?

THE WITNESS: The doctor says it is arsenic suboxide. Does that prove that it is arsenic suboxide, if arsenic suboxide has never been known to exist, and you cannot prepare it pure, or find its properties. He has hypothecated arsenic suboxide to explain something that covers up his ignorance.

THE COURT: Well, that might be so, but here is a substance that you say has never been known to exist that textbooks for a hundred years have all carried as a chemical substance. In 1925 a series of experiments undoubtedly threw a lot of doubt upon it, but I don't know that you can start out with the proposition it has never been known to exist.

THE WITNESS: Well,—

THE COURT: Maybe you can.

THE WITNESS: — perhaps I should not have said never has been known to exist, but if we trace these experiments that have been done on lead suboxide, trace down through the history, we

will find we have a very peculiar situation. First one man finds certain properties for it. When more accurate—well, I shouldn't say more accurate, I can see a pitfall there ahead of me, but when other experimenters carry out the same experiments in every case it has been found, excluding the present X-ray case, that the ones who had found suboxide had made a mistake somewhere along the line, and that later it was shown where that mistake was, how they happened to fall into the mistake.

THE COURT: Well, all I want to be sure of is that you are dealing, so that we won't have confusion, all I want to be sure of is that you are dealing with Dr. Clark's real testimony, with what he really intended to convey.

THE WITNESS: I think I am.

THE COURT: I don't believe the discussion is worth the time we are putting on it, because it may be just a matter of words, anyhow.

(Discussion off the record.)

By MR. MORRIS:

Q. Dr. Ewing, just one question, and that is of the relative fineness, will you please describe the relative fineness between the Toronto product and the Exide or defendant's gray oxide product?

A. The two photomicrographs which I submitted on these two samples show that the oxide in the Toronto product is a little finer than the oxide in the Exide product, but there is not very much difference; practically the same. The lead particles in the Toronto product are a little finer than the

lead particles in the Exide product, but here again, not much different.

Q. You are speaking of Dr. Wilson's samples taken from the Toronto mill operated on January 11, 1935, I assume; are you, Dr. Ewing?

A. The oxide was submitted—was taken January 11, 1935. The Exide was taken August 3rd, 1934, mill number 3.

Q. Both of them Dr. Wilson's samples?

A. Yes, sir.

MR. MORRIS: That is all. You may cross-examine.

*Cross-examination.*

By MR. WHITCOMB:

Q. Dr. Ewing, referring to Plaintiffs' Exhibit 27, showing these large crystals, I understand that you found on examination a rate, in your notebook, or drew some pictures in your notebook which in your opinion do correspond to what Dr. Clark found, excepting you make a difference in the distinction as to what they are. Is that right? In other words, you did find—

(Plaintiff's Exhibit number 27 was shown to the witness.)

A. I found large crystals similar to those which are shown in those photographs, yes—similar in appearance, I should say.

By MR. WHITCOMB:

Q. Now, I am informed that the index of refraction of those materials is 2.55 plus or minus — 2.553, plus or minus .002. What is your index of refraction for the material you found?

A. I did not determine it.

Q. Well, you did not determine the index of refraction?

A. No, sir.

Q. Well, isn't that one of the outstanding criteria of distinguishing particles from the physical analyses?

A. Yes, sir.

Q. You did not do that?

A. No.

Q. What is the index of refraction for lead carbonate, do you know that?

A. I don't know.

Q. You didn't look that up?

A. No.

Q. And you didn't compare that with these large particles that you found?

A. Lead carbonate?

Q. Yes.

A. Not at that time.

Q. Well, have you ever compared the index of refraction of lead carbonate?

A. I have done nothing on index of refraction.

Q. Are these third type particles that you have drawn in a rough sketch in your notebook uniaxial? We are dealing now with the question of how they are to be viewed under these polarized or unpolarized lights.

A. I don't know the crystal structure of these particles at all.

Q. Is lead carbonate uniaxial?

A. I don't know, I am not acquainted with the crystalligraphy of lead carbonate.

Q. Is lead oxalate uniaxial?

A. I am not acquainted with the crystallography of any of these lead compounds.

Q. Isn't yellow PbO biaxial?

A. I cannot answer.

Q. Now the subject of valences, you went into that?

A. Yes, sir.

By THE COURT:

Q. Could you tell me in a very few words what is the index of refraction? What is meant by that expression?

A. Well, roughly, it is tied up with the amount of change in direction of light when it passes through materials.

By MR. WHITCOMB:

Q. And each different substance has a different index of refraction, does it not? That is a recognized method of determining—

A. That is one of the properties of crystals, yes.

Q. Referring to valences, now, why does manganese have a valence of 7, 4, 6, 3 and 2 in different combinations? You know that it does, do you not?

A. Yes, sir. Well, to explain that question we would have to go into the electronic structure of the atom.

Q. But you are willing to admit that certain substances, particularly manganese, for one, and others, do have these different valences?

A. Oh, yes, sir. That is a well-known fact.

Q. Can you positively say that any chemical element in a certain periodic group, or having a certain value, cannot have another valence in its compound?

A. I don't believe I get the gist of that question.

THE COURT: I don't know what you mean by "in a certain periodic group".

MR. WHITCOMB: Well, that is the valence, again, and the atomic weight.

THE COURT: All right.

MR. WHITCOMB: The periodic group; all substances, as I understand it, are divided into these chemical groups, due to the atomic weights.

THE COURT: All right.

MR. WHITCOMB: That is one first classification.

THE COURT: Well, just the word "periodic".

MR. WHITCOMB: Yes.

By MR. WHITCOMB:

Q. What I am asking is, we know a certain valence of a chemical element. Now, it enters into combinations?

A. Yes, sir.

Q. Now, can you positively say that all chemical elements do not have a different valence when they enter into a new combination of the element, an oxide or some other compound?

A. I am sorry, I don't understand the question the way it is put.

Q. What part don't you understand?

A. Well, this different chemical valence when it enters into a compound; different from what?

Q. Different from what it has, as an element, per se?

A. Oh, absolutely, the valence of the element is zero, in any compound they are some number; lead coming into monoxide becomes two, into the peroxide it is four, in free lead it is zero.

Q. Suboxide, what would it be?



A. If suboxide exists it would be a valence of one, that is, if suboxide has the formula  $Pb_2O$ . If the suboxide had some other formula, of course, it would be a different valence.

Q. Then you admit that many elements might have one valence and then enter into a compound and have other valences?

A. Yes, I can give you a list of some—

Q. Yes.

A. — forty or fifty of them; more than that, all except those in the zero group.

Q. Yes. Assume solutions of lead acetate in two vessels, one heated, and one not heated, connected by electrical wire. Is there a current? There must be the lead electrode. The current passes, is that right?

A. Different concentrations of lead acetate?

Q. Same concentrations, but different heats.

A. One heated and one not—I cannot swear to the answer to that. I think that is tied up with some so-called effect in physical chemistry, but I don't remember the name and I am not sure of my facts on that.

Q. I am advised by Dr. Clark that it does. Do you think that would be sufficient in that case?

A. I think probably that is sufficient. He probably could tell you the name of the effect.

Q. If that is true what would it indicate, particularly with relation to the formation of the acetate? To be more specific, does it form a mono-acetate?

A. I am not acquainted with the reaction. I don't know.

Q. Now, coming to the subject of densities, how do you determine the density of a substance?

A. It varies according to the type of substance, which we have. Solids, you mean?

Q. Yes, powder sample like we are talking about here.

A. You want me to describe the method of determining the density of lead oxide?

Q. Without going into too minute detail, yes.

A. The method we used was to use a small bottle with a very fine capillary neck, called a pycnometer. The neck was removable, tube, so that we could place—so that we could easily get the powder in, treat it with some good wetting agent, we used toluene, evaporate off the toluene and repeat that many times until we were sure that the air had all been displaced; fill the tube up to a certain level with toluene, control the temperature accurately, weigh the certain volume, and calculate its density.

Q. All right, doesn't the packing make a difference in the density, I mean, the natural packing that would take place?

A. No, sir.

Q. Why not?

A. Because this wetting agent penetrates in between the particles of the solid powder and fills up all the interstices.

Q. But does the particle size make any difference?

A. Not within the limit of error of which a determination of this type is made.

Q. You say the liquid penetrates the different cracks and crevices?

A. Yes, sir.

Q. Would your density measurements of fifteen or twenty different samples of one test lot all be the same?

A. They check very, very closely. Dr. Ullmann has the data on that. I don't have it.

Q. Close enough so that an addition of, say, four per cent. of suboxide, assuming it exists, would be detected by this—

A. You cannot answer,—

Q. —and not be within those variations?

A. You cannot answer that question unless you know the density of the suboxide. It should be possible to calculate the density of the suboxide from X-ray diffraction patterns; if you have X-ray diffraction patterns of the suboxide.

Q. Well, is it your opinion that four per cent. of such a calculated density in such a suboxide would be able to be detected by your methods of measuring the densities of these samples?

A. You cannot answer that question until you have found out what the density is, first. If the density should come out to be identical with the lead oxide, why, of course, there would be no difference.

Q. Then, at least, in that instance you would not be able to detect it by that method?

A. If there is no difference you could not detect a difference.

Q. Well, there might be a small amount of difference?

A. There might be a large amount of difference.

Q. And only four per cent. of the added material would give you a range of what variation?

A. The question cannot be answered unless the density of the material is known.

Q. What was the source of lead in the so-called synthetic mixtures you made, lead and lead oxide, in the different tests you described?

A. In density work?

Q. No, in any work, it is not limited, this is not limited to density, now. You testified about making

up some samples of metallic lead and lead oxides, did you not?

A. I don't recall testifying to that.

Q. You referred to Dr. Ullmann, then, making some tests, is that it?

A. I don't recall testifying to any synthetic tests made on synthetic mixtures. I may have, and it slipped my mind.

Q. Well, did you make any such tests?

A. No, sir, I did not. Dr. Ullmann may have. I think probably what—where the confusion arises is that I referred to the density of a synthetic mixture in which the density was calculated from known values of lead and lead oxide.

Q. Well, but did you actually use metallic lead?

A. We did not make those measurements, we used values from the International Critical Tables for the density of lead and the density of lead oxide.

Q. Now, in connection with the question of amalgamation, assuming the existence of a suboxide as testified to by Dr. Clark, would the mixture of such an addition of, say, four per cent. to the material you used do substantially the same thing you testified to with respect to the amalgamation?

A. Do you mean, could a—could four per cent. lead suboxide be determined by the method?

Q. That is what it amounts to.

A. That is the—

Q. In other words, could you detect a difference of four per cent. added amount?

A. Yes.

Q. Wouldn't it go into the amalgamation?

A. Lead suboxide amalgamate in mercury? I believe not. Berzelius's reason for postulating lead suboxide was that it would not amalgamate.

Q. You disagree with Berzelius, then?

A. No, I think it would be a very peculiar chemical compound if it did amalgamate. I think of no other oxides that amalgamate.

Q. If it did amalgamate then your test about the mercury would not prove any scientific fact about this, would it, because you would be getting out your lead, then, and would have an unknown substance right in with the lead result, isn't that true, the same as on the other end, if you tried to separate the oxide from the mixture, and you get all oxide, you don't know whether there is a proportion of  $PbO$ , or possibly—and possibly other oxides, so that unless you know that lead suboxide does not amalgamate—

A. Just a minute, please,—

Q. — with mercury you haven't proven anything?

A. Just a minute. What is seven per cent. of four per cent.? Two thousandths of a per cent. would be the amount of oxygen in four per cent. of lead oxide which would be present, since there is seven per cent. of oxygen in lead suboxide. Consequently, I don't believe that we could detect the difference of two thousandths of a per cent. of oxygen in the amalgamation process.

By THE COURT:

Q. Is that two thousandths of a per cent., or two thousandths of the whole?

A. It is four per cent. of seven per cent.—or seven per cent. of four.

Q. Well, either way.

A. No, four per cent.—

Q. Either way.

A. Either way; point two zeroes twenty-eight.

Q. That is the whole, though, that is not of one per cent., that is two thousandths of the whole?

A. Of the total sample.

Q. Of the total sample, yes.

A. Yes.

Q. But not two thousandths of one per cent. of the total?

A. No.

By MR. WHITCOMB:

Q. No, I think the judge is right, isn't he, Dr. Ewing?

A. Yes.

Q. .002 of the whole?

A. Yes.

Q. Because you have already taken your percentage of your percentages?

A. Yes.

Q. Will you please now refer to Defendant's Exhibit 179 and state how you know that lead is in the colloidal state?

(Defendant's Exhibit 179 was shown to the witness.)

A. In particle size determinations under the microscope the photograph is taken of the dispersed particles and measurements are made upon these photographs and suitable calculations made to determine the diameter. If the particle is of the range of a tenth of a micron, due to the nature, or, due to the wave length of light, it is not possible to sharply resolve these particles of one-tenth of a micron in diameter under the microscope. That is a limitation Nature has imposed. Consequently, in determining these particle sizes when we come to a particle which gives a faint blur on the photograph, a blurred point,

we automatically assign to that a value of one-tenth of a micron. It may be smaller. We cannot tell.

By MR. WHITCOMB:

Q. But how do you know that that might not have been—

A. I find these blurred particles on the photograph.

Q. Yes, that is true, I understand you do, but the question is, how do you know it is lead? Might it not be just as well suboxide?

A. Why, I stated that I—when these pictures were taken the particle undoubtedly was no longer lead. The original particle was lead when I made the mark, but these fine particles oxidize very rapidly in the air, and I made the further condition that they might grow when they are oxidized, but it is hard to conceive that the size would diminish with addition of oxygen to it.

Q. That is all very true.

A. Yes.

Q. Then your testimony now is that you don't know that that is lead?

A. My testimony is, was and is that the particle originally was lead, as far as I—

Q. Now, we will come to that in a moment.

A. — can judge from my method of preparation.

Q. Then your testimony now, or at any time, that you do not believe it is lead in that picture, Exhibit number 179?

A. Yes.

Q. But I thought you were undertaking to show that metallic lead particles in contradistinction with Dr. Wilson's report could not exist in such a small size.



A. My testimony was that they can be made by grinding and were made on the paper by grinding, but after they were made they immediately oxidized. I cannot prove that they immediately oxidized, but that is the property of finely divided lead, that it will oxidize in air.

Q. Well, now, all right; come to the question of your paper. This was when you put a lead mark on a piece of paper.

A. Yes, sir.

Q. Didn't that generate a heat and raise the temperature?

A. No.

Q. You are sure of that? Do you know that lead—

A. It may have generated a temperature of a thousandth of a degree or less.

Q. Are you willing to swear positively that that was lead on the paper, and not an oxide of lead?

MR. MORRIS: You mean what was put on, or what was there after what was put on was on?

MR. WHITCOMB: What was on after he got it on.

MR. MORRIS: He has sworn twice that he believed it to be an oxide.

MR. WHITCOMB: I am asking him.

MR. MORRIS: No, I know, but this is repetition. He said in his direct and now that it was an oxide in his belief, and, furthermore, I am objecting because the assumption, the inference to be drawn from the question of the learned counsel is contrary to the evidence.

THE COURT: Well, the only thing that I see

about it is that it is probably repetitions. Let's get it settled finally.

By THE COURT:

Q. What is this, what was on the paper immediately after you drew the lead—

A. To the best of my knowledge and belief, it was lead.

Q. And not lead oxide?

A. And not lead oxide, made by rubbing a piece of lead which had been very carefully cleaned on emery paper.—

Q. All right.

A. — and other paper, and lightly marked on this.

THE COURT: Well, that settles, at least, it settles your testimony.

By MR. WHITCOMB:

Q. Wasn't there a film of oxygen on the paper?

A. Yes.

By THE COURT:

Q. Now, you also said, as I understand, that it did not remain lead very long, or did not remain lead—was not lead at the time it was photographed?

A. Not the time it was photographed, no.

Q. And what was it at the time it was photographed?

A. It was an oxide of some kind, undoubtedly.

THE COURT: Well, all right.

By MR. WHITCOMB:

Q. Now, Dr. Ewing, Plaintiffs' position, as you certainly know, is that Dr. Clark has testified that

he himself has found a suboxide and thoroughly believes there is one.

A. Yes, sir.

Q. Well, now, I would like to ask you, with that in mind, from your point of view that you make the assumption that there is suboxide, and then state whether or not all those eight rates of action going on as testified to by Dr. Clark would be true or not. This is a hypothetical question, of course.

A. Well, I can knock out one of them at once. I don't believe that the second one is right, whether he assumes—that is the rate of the blast controls the thickness of the absorbed film.

By THE COURT:

Q. You mean whether there is or is not such a thing as lead suboxide there,—

A. Yes.

Q. — that still would not be true.

THE COURT: All right.

By MR. WHITCOMB:

Q. Well, do you know the standing of Walker, Lewis and McAdams, "Principles of Chemical Engineering"?

A. Yes.

Q. Is it a recognized—

A. Standard text book.

Q. Well, on page 38 it says:

"If the main body of the fluid be flowing over the surface of the solid or liquid, a rolling or turbulent motion will exist at the surface of the boundary film, and this will wear away or rub off a portion of it, causing what amount to convection currents to strike more deeply into it.

The thickness of the film is thereby decreased and any action resultant upon the presence of the film will be influenced accordingly."

Do you agree or disagree?

A. I would have to know when he said thickness of film, whether he meant adsorbed film or not. If he means adsorbed film I will have to disagree. If he means a film that is on there by wetting, why, he is probably right.

Q. Well, then, as long as there is a film there you agree that he is right?

A. No, sir.

THE COURT: He says if it is an absorbed film he disagrees.

By MR. WHITCOMB:

Q. Excepting you make the distinction if the film is absorbed it would not be correct?

A. I don't believe "absorbed" is the word.

Q. "Adsorbed"; I beg your pardon; could there be a film there that is not adsorbed?

A. Yes.

Q. And then in that event—

A. The same as you could have a film of water on the sidewalk, it is not all adsorbed water.

Q. Well, might that not be going on in these mills? Isn't there a sweeping over each particle in some part of the action?

A. Not affecting adsorption.

Q. I am not talking about adsorption.

A. All right, there is air going through the mill, I don't know—

Q. Well, then, would this be true, that "the thickness of the film is thereby decreased and any action resultant upon the presence of the film—

THE COURT: Well, but, Mr. Whitcomb, Dr. Clark, as I understand it, the film he was talking about was absorbed film, nothing else, wasn't it? What is the use of examining about something else that was not—

MR. WHITCOMB: Well, of course, there is a question of how much, whether it is totally absorbed—

THE COURT: Well,—

MR. WHITCOMB: — or combined film, I don't know.

THE WITNESS: Well, adsorbed and combined film are practically synonymous terms.

By MR. WHITCOMB:

Q. In any event, you do not disagree with this statement in this paper, with the limitation you put on?

A. With the limitation I put on, I do not disagree.

THE COURT: They want to change stenographers at this point.

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WARREN W. EWING, recalled. \_\_\_\_\_

*Cross-examination (Continued).*

By MR. WHITCOMB:

Q. Well, then, on all the other seven actions you agree he would be correct in that, or what is your testimony?

A. I didn't get that far, you interrupted me.

(Discussion off the record.)

THE WITNESS: Of course, the third has nothing—well; the third has nothing to do with the postulation of  $\text{Pb}_2\text{O}$ .

By MR. WHITCOMB:

Q. Well, what is your answer to that, then, about the third?

A. Why, I agreed to that in the beginning.

Q. Yes. All right.

A. The fourth for you to postulate is that the reaction of oxygen on lead is the formation of lead suboxide. Of course, there will be a rate of chemical reaction, the action to adsorb, or the action of adsorbing oxygen on lead.

Q. Then you agree with Dr. Clark on that under this hypothesis?

A. Under this hypothesis, yes. The rate of diffusion of oxygen throughout the protecting layer of  $\text{PbO}$  has nothing to do with lead oxide.

Q. You agree that that happens?

A. I agree that there is a diffusion there, and I believe there is some condition about the rate of removal by abrasion—the rate of removal by abrasion has nothing to do with  $\text{Pb}_2\text{O}$ —and I agree that there must be a rate of diffusion, the date of disassociation.

Q. Of suboxide?

A. Suboxide,  $\text{Pb}_2\text{O}$ . Well, there is a little—there's a lot that can be said on that, but I don't believe it is worth while. If  $\text{Pb}_2\text{O}$  exists and if it decomposes according to the postulated theory, why, of course, it can be decomposed at the given rate—and which is, in my opinion, very close to molecular lead. The fourth for  $\text{PbO}$ —

Q. What's the fourth?

A. Not the fourth, the eighth. The rate of oxidation of  $Pb_2O$ —if  $Pb_2O$  exists and if it oxidizes rapidly in the air at the temperature of the mill, of course, there must be a rate of oxidation.

Q. I believe you made certain deductions with respect to this powder when immersed in a film of water or in water. State what was the condition of the sample.

A. Are you referring to the finding of these crystals under the microscope after the substance had been placed in water?

Q. Yes, when it is completely submerged and so forth?

A. Yes, sir. It was a little of the gray oxide placed on the point of a knife, it was shaken on the microscope slip, covered with water, stirred around with a glass stirring rod, lightly smeared out, and allowed to dry—ideal oxidizing conditions—and then the dry material examined under the microscope.

Q. Did you try heating any of the powder?

A. No, sir. But, if it were the red lead oxide and we heated it to the transition temperature, it would then go into the yellow oxide, and you would have a blackened effect on the surface due to the crystalline change.

Q. At what temperature would that be?

A. I believe it came up in Court yesterday that that transition temperature was 585 degrees—I'm not sure.

Q. It was very high anyway. Centigrade?

A. Centigrade, yes. 585 degrees.

MR. MORRIS: That is all.

MR. MORRIS: That's all, Dr. Ewing.

THE COURT: Did you find out about that supplemental report of Dr. Wilson's?



MR. MORRIS: It is all right. If he made a supplemental report, with respect to his second examination, it would be but a repetition of what is already disclosed in the original report. If he found anything different at all—if he finds anything different at all, I will be glad to have it shown.

(Discussion off the record.)

MR. WHITCOMB: Of course, in that connection remember, your Honor, we have got the testimony in of those old records, showing how it would drop off in an hours run of several hundred.

MR. MORRIS: Incidentally, I think the record should show that the day your Honor visited the plant with Dr. Wilson—which, as I recall it, was on Thursday morning of last week—Dr. Wilson brought back a number of bundles of the record, which the Plaintiffs now have in their possession—

MR. WHITCOMB: That's true.

THE COURT: Yes.

MR. MORRIS: — and that those—I think it should also show that those were selected by your Honor or by Dr. Wilson at random.

THE COURT: No, I didn't select them and I didn't see them selected, but Dr. Wilson states that they were selected at random by him.

HARRY W. ULLMANN, was called as an expert witness on behalf of defendant and having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

I am head of the Department of Chemistry at Lehigh University. I have occupied that position since 1913, I think it is. Yes. I am a graduate Ph. D. of the John Hopkins University in chemistry. I didn't occupy any position of any account between the date of graduation and going to Lehigh. I was a student. I have formed an opinion as to whether or not there is any lead suboxide to be found in the Defendant's product. My opinion is that the defendant's product does not contain lead suboxide. My opinion, from all that I have read and from the things I have done myself and from the testimony that I have heard, is that there is no such compound as  $Pb_2O$ .

Q. Will you proceed, in your own order, to tell me why you arrived at those conclusions?

A. In approaching a topic of this kind, we naturally consult literature on the subject. There is no use going back to Berzelius, Pelouze, and Bouissin-gault, who worked a hundred years ago. In this particular case, as I understand it, the evidence of the plaintiff is submitted from zero. As we look through the literature, we find a number of statements about lead suboxide, we find that a more recent—we find that the more recent statements, made particularly when men have had the advantage of X-rays—we find that that testimony, with the exception of the testimony of Ferrari and the testimony of Dr. Clark, made by men of the highest rank, is to the effect that lead

suboxide either does not exist or that they could find no reason for supposing its existence.

This work goes back to a number of men. We have the work of Le Blanc and Eberius, Le Blanc being one of the greatest chemists in the world. We have the work of van Arkel and we have the work of Darbyshire, who was the leader of all X-ray analysts, and Professor Bragg, and cannot find any reason for supposing that there is the compound lead suboxide. We have the opinion of Fricke and Ackerman, who did a great deal of work on the subject, who go so far as to say it is time to strike all reference to lead suboxide from the literature. We have the work of Dr. Davey and the work of my colleague, Professor Anderson, who likewise say it is impossible to find the substance.

I should like to go through this in some orderly fashion, due to the fact that I may not pass through the whole of what I want to say, and I shall try to be as brief as possible.

THE COURT: Pardon me, we can relieve you by having your notes read by someone else. You are perfectly free to ask Dr. Anderson or anyone you wish to read.

THE WITNESS: Thank you, sir. I will try to have enough voice to last through the cross-examination.

MR. WHITCOMB: Yes.

By MR. MORRIS:

Q. Won't you proceed, Dr. Ullmann?

A. In the first place, the matter of color has been brought up—as to why the material made of a blue-black substance like lead and the red substance like

tetragonal lead oxide should be green. Of course, when tetragonal red oxide of lead is ground fine, its color is yellow and the finer it is ground the lighter yellow it becomes.

I have here an exhibit, in this little box, which contains, in the first place, at the top here, fine metallic lead, and the next is red oxide of lead—and when that red oxide of lead is ground it becomes a light yellow, and if we mix this light yellow lead oxide—

Q. Will you pardon me just a moment?

A. Yes.

MR. MORRIS: I ask that the exhibit to which Dr. Ullmann is referring be admitted in evidence as the Defendant's Exhibit 180.

(Box containing card was then marked as Defendant's Exhibit No. 180.)

By MR. MORRIS:

Q. All right. Will you proceed, Dr. Ullmann?

A. Well, at any rate, when we mix this red oxide of lead that has been just ground—ordinarily, in a mortar—with fine metallic lead, then we can get various shades of green, any shade that we like. I have chosen those two shades as being, as approximating, the Defendant's oxide. If you like, they can be lighter or darker. Those, as you can see, are olive green.

The next—I will try to be as brief as possible—the next matter I should like to bring up, also a physical test, is the determination of density; the specific gravity, of the Electric Storage Battery Company's gray oxide. These determinations were made with the greatest care. We found early it was necessary to remove, as far as possible, all adhering air and, if possible, any absorbed air from the surface

of the oxide and also from the surface of the materials that we used as standard.

This was done in a recognized form of apparatus. The air was removed by treating the materials with a substance that would wet it like toluene, of a high purity and perfectly dried, of course. The toluene evacuated and this was repeated, and then the density was determined in toluene by well-recognized methods.

The samples examined were official samples under the screen finished product—two different dates—one phosphorous pentoxide and the other one not. As to the agreements of these densities with the densities calculated for mixtures of this type, the agreement is excellent.

If I may explain for a moment, we determined, analytically, the percentage of lead and lead oxide in this substance, and then we weighed the substance with its gravity and weighed the lead oxide with its gravity, taking them pro rata—that was to find out what the calculated gravity should be—and we find it is very, very close. I have made a calculation here, because I imagined it would come up, of what the effect would be if the substance—if this contained some known substance. Of course, I would have to take some substance of which the gravity was known, and I took, because it had been mentioned in this case, lead carbonate, which has a gravity of about 6.6, and I calculated that our method used would have discovered as little as two-tenths of one per cent. added to this mixture—that is, the addition of as much as two-tenths of one per cent. of lead carbonate would have vitiated the results that we got.

By THE COURT:

Q. Well, you could probably answer the question

I have asked several times here, and that is if I give you a mixture and tell you it contains nothing but lead and oxide of lead, can you satisfy yourself absolutely that that is correct?

A. Yes.

Q. By your tests?

A. Oh, yes. Yes.

Q. By chemical analysis?

A. We can also do it by chemical analysis.

Q. You can, by chemical analysis, in other words, establish conclusively that a mixture has nothing but lead and lead oxide or some lead oxide?

A. Yes. The way we do that is we determine the lead—

Q. Yes.

A. — and, independently, the lead oxide; and, if that adds up to within, two, three, or four-tenths of a percent.—of a hundred—we take it for granted that we have covered the constituents.

Q. Can you, then, by chemical analysis, tell what oxide of lead it is?

A. Well, if it had lead oxide in it, you could tell that by chemical analysis, yes.

Q. I was just wondering what was the fullest report you could give me, by chemical analysis, on a compound which I hand you and say I believe it contains lead and mixed with that some oxide of lead which I don't know or can't identify, what will be the fullest report you can give me?

A. I would like to have you specify, in order to save time, that it is a mixture, say, of lead, lead oxide, and the specious lead suboxide. Of course, if it is not any real lead suboxide, I can't determine it. As a matter of fact, I haven't thought it worth while to attempt an analysis of this type.

Q. I understand, but I just—

A. Yes. It could be done, anybody could do it.

Q. — wanted to know, can you identify the oxide that is present?

A. From an analysis, you could identify not only that it was present but even determine the quantity present.

Q. Of any oxide?

A. Now, you say "any oxide",—of course, I will have to think. Any known oxide, yes.

Q. How much of the mixture was lead and how much was oxide?

A. Yes, you can tell it, if it had lead suboxide, and if you would like to have a demonstration of that—

MR. MORRIS: If you will explain—

THE COURT: Oh, I understand it.

MR. MORRIS: But I am sure Dr. Ullmann will explain how he does that as he proceeds.

THE WITNESS: If you would like to have it—

THE COURT: Well, I don't know. As far as I am concerned, I accept your statement that it can be done. That's what I have been trying to find out.

MR. WHITCOMB: We are informed that it cannot be done.

(Discussion off the record.)

By MR. MORRIS:

Q. Will you proceed, please, Dr. Ullmann?

A. Well, I neglected to say, in qualifying, that for a long time I occupied the same position at Lehigh that Dr. Clark does at Illinois, in regard to quantitative analytical work.



I have here a lot of details that won't interest you—for sample, calculation for density—which I suppose we can leave out or will it, possibly, be taken for granted?

THE COURT: Go ahead.

By MR. MORRIS:

Q. Yes.

A. In view of the excellent testimony given by Dr. Ewing, I can pass over the mechanical separation of Pb from—that's the E. S. B. gray oxide. It can be shown that all these tests point to a mechanical mixture of lead and lead oxide.

Q. Any kind?

A. No. E. S. B. gray oxide.

(Discussion off the record.)

By MR. MORRIS:

Q. Proceed.

A. I next come to the problem of amalgamation. This is an old topic in this field. From our experience in density determinations and from what we know in general about substances, we decided that we might be able to amalgamate all the lead out of the E. S. B. gray oxide by following a careful technique and freeing the E. S. B. gray oxide from air, so that the amalgam might touch the lead.

You understand, of course, that there is a layer of air on many kinds of materials. That explains, for example, why when you drop water on fine material like dust on the floor the drop of water goes over the floor and does not wet the floor on a dusty floor. If you take the air off the small particle of dust, why the water will wet the dust.

This was carried out on the E. S. B. gray oxide

by methods which we shall publish in the literature—we are assured that what we submitted for publication will be published in the literature—and we find that E. S. B. gray oxide gives results of lead by amalgamation which agree very closely with the determination of lead by analysis. That is, we can actually pick the lead out with mercury and get it all. All that is shown by analysis.

This, furthermore, confirms the view that E. S. B. gray oxide is simply a mechanical mixture of lead and lead oxide, and again explains all its properties in respect to amalgamation just as it explained, fully and in a perfectly satisfying way to a chemist's mind, that it was nothing or is nothing, simply, but lead and leadoxide, as determined by the density measurements. I may here say that we tried every method—

Q. Dr. Ullmann, will you pardon the interruption—

A. Yes.

Q. — because I didn't get clearly from your amalgamation process your complete results—now, if you said it, I missed it—you dealt with the amalgamation which picks out the lead, but you have not analyzed the remainder nor have you mixed your two ingredients and then analyzed them in the same way?

A. Please get me—I think it's in the box—it's that little amalgam tube. Will you get it, please?

(Discussion off the record.)

THE WITNESS: The method of analysis which, I say, we shall submit as a scientific publication—

By THE COURT:

Q. May I ask if this a new method of analysis?

A. Yes. No one has ever amalgamated any of these products before, to my knowledge.

By MR. MORRIS:

Q. The reason they could not is, as you conclude, what, Dr. Ullmann?

A. Why, they haven't taken the pains to remove the air from the surface of the lead and the lead oxide.

Q. Then you found, when you took the pains to do that and thus treated it with mercury—when you take the necessary pains to do that and then treat it with mercury, it will amalgamate?

A. It amalgamates completely, yes.

Q. If you will be good enough, Dr. Ullmann, tell me how you know whether the remainder of your original mixture is  $\text{PbO}$  or something else—that is, when you get to it? That's what we are getting to now, is it?

A. Yes.

Q. All right.

A. Do you want the—the remainder of the mixture is  $\text{PbO}$ —the  $\text{PbO}$  is rather distributed and it is difficult to collect it all and find exactly how much of the  $\text{PbO}$  is present. What we amalgamate, of course, is the lead, and we find that the lead agrees wholly with the analysis we make, showing—

By THE COURT:

Q. You don't actually collect the residue and analyze that—you subtract the lead from your prior analysis figures?

A. No. We actually determine the lead—

Q. Yes.

A. — actually weigh the lead we got in the mercury—

Q. Yes.

A. — and that agrees with the lead that we get by analysis.

Q. Yes. I am correct in saying you don't collect the residue and make the—

A. We can't very well collect it. I imagine, if we worked carefully enough, we could but we didn't think it was worth while.

By MR. MORRIS:

Q. But you do ascertain, Dr. Ullmann, do you not, what the remainder of that mixture was or is?

A. That mixture—

THE COURT: Well, now, he ascertains it before he starts in. Don't you.

MR. MORRIS: I don't seem to be able to get the thought that I have in my mind over, but he does ascertain it, and I would like for him to tell us how.

THE WITNESS: Why, what we do, if we like, is to dissolve the rest of the mixture in acetic acid and show that it dissolves wholly. When we have done that—

THE COURT: You didn't do it in this case?

THE WITNESS: Oh, yes, we dissolved it in this case; but we don't try to collect it in a quantitative way.

By MR. MORRIS:

Q. Is it that you take two samples from the same batch and then you treat one with lead and you treat another—you treat one with mercury for amalgam?

A. Yes.

Q. And treat another sample from the same batch with acetic acid?

A. Yes.

Q. That's what we want to get, Dr. Ullmann.

A. Yes. Thank you, very much. These two results, one I get by analysis,  $\text{PbO}$ , and the one I get for this—

Q. Pardon me, Dr. Ullmann.

A. It's too bad we haven't had a conference about this.

Q. Now, then, did you make a synthetic mixture of lead and  $\text{PbO}$  and, if so, did you analyze that and what comparable results did you get that were comparable or otherwise with your gray oxide tests?

A. Well, I will have to go back a bit. This is a very difficult operation. In the first test, we couldn't get total amalgamation, and then there was no method known which was working satisfactorily for determining, analytically, how much lead there was in this large quantity of mercury. And, while we weren't getting very exact results, we did put together a synthetic mixture, but that synthetic mixture didn't give us wholly satisfactory results about the lead, simply because there was no analytical methods known at that time. Since we have had this very accurate method, it really has not occurred to us to make a synthetic mixture. It is absolutely useless, as a matter of fact. No chemist would ask me to do it.

Q. That means to a layman what? What percentage of lead did you get by your amalgamation of the gray oxide?

A. The percentage of lead, by amalgamation—this is an official sample—26.48 and the lead, by analysis, was 26.68.

By THE COURT:

Q. Per cent.?

A. Per cent., yes, sir. Now, we took the precaution, of course, of determining this 26.68 per cent. lead by analysis; not simply by difference but actually determined it as lead, as well as determining it—as well as checking that by subtracting the PbO from a hundred.

In another case, we have lead, by amalgamation, 33.92 per cent.; lead, by analysis, 34.27.

Another case, we have lead, by amalgamation, 33.25; lead, by analysis, 33.

I think it might be well, just for a moment, to indicate the method so that my chemical friends here can be satisfied with it. The mercury—

THE COURT: I think, perhaps, we had better reserve that until after lunch. It is half past twelve now, and we can start right at that point. Court is adjourned until two o'clock.

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(Recess, 12.30 to 2.00 P. M.)

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AFTER RECESS.

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Present: Counsel as before noted.

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HARRY M. ULLMANN, recalled.

*Direct-examination (Continued).*

By MR. MORRIS:

Q. Will you proceed, at your convenience, Dr. Ullmann?

A. We are going to give some brief description of the actual method of amalgamation and analysis used. The material to be amalgamated is put into a tube like this (indicating); and then mercury is put in, and it is exhausted, and toluene put in, and exhausted repeatedly.

By THE COURT:

Q. What do you mean by exhausted?

A. Oh, put a vacuum on it, to draw off the air and the toluene.

Q. And the mercury, what do you draw off then?

A. The mercury is heavy, and stays in the bottom. This tube is evacuated still.

Q. Yes.

A. There is no air, at least, very low vacuum in it.

Q. Yes.

A. You draw the air off.

Q. Yes.

A. And the toluene, wetting the material, helps to draw the air off the outside of all this substance.

Then mercury is put in. Then it is put in a shaking machine, and depending on the amount of air that is left on it, on the material, it is shaken in a machine like that (indicating). It has to be shaken quite a while to get a thorough amalgamation.

By MR. MORRIS:

Q. Of what?

A. Thorough amalgamation of the lead and the material.

By THE COURT:

Q. With the mercury?

A. With the mercury. That is sealed like that



(indicating), they are strapped on to a little machine, it has an eccentric motion, like that (indicating).

Q. Yes, I understand. and what is this mixture that is in this tube?

A. That is the original gray oxide, mercury in it. The mercury in this picks up the lead, amalgamates the lead, and this other material is there, of course, is the rest of the material, the lead oxide.

Now, having gone that far in our earlier tests we had one great difficulty in determining a comparatively small amount of lead in a great deal of mercury. It is a very difficult chemical, analytical operation. In the later development of the method we simply drove off some of the mercury in a vacuum until we had a very small amount of mercury and amalgam, and we dissolved that, that could be—and the mercury dissolved in sulphuric acid. It seems that acid sulphate of mercury is soluble in sulphuric acid.

By MR. MORRIS:

Q. Sulphuric or nitric?

A. Oh, it is a residual—it is one step, I omitted one step there. The mercury and nitric acid, the mercury, amalgam and the mercury are treated with nitric acid and dissolved, dissolving both mercury and lead; and then it is treated with sulphuric acid. The acid sulphate of mercury is soluble. The lead is precipitated as lead sulphate and determined in the usual way, with the usual precautions, and using water saturated with lead sulphate, and so forth, and so forth. In that way we get a determination of the lead that is amalgamated very accurately.

For our own use and purpose of publication we made synthetic mixtures of pure lead and mercury, knowing the amount of lead that we put with the mercury, then went through this same treatment and

recovered all the lead that we put in, showing the method of separation and analysis is a good method.

Dr. Ewing has covered pretty well the subject of microscopic examination, together with the treatment of the gray oxide, so that it might be properly examined.

I have here an experiment which will illustrate how readily the mixture of toluene, with a small amount of lecithin—

By THE COURT:

Q. Small amount of what?

A. L-e-c-i-t-h-i-n, lecithin—separates the oxide from the lead that has been shaken up. See how rapidly the lead settles, and this up here, now, is mainly lead oxide (indicating). There are figures given as to just how much that is. This, if I may say so, Your Honor, without attempting to be facetious at all, is an equivalent of an egg shampoo. Lecithin is the material contained in the yolk of egg which makes it a good shampooing material.

Q. Yes.

A. The gray oxide is simply put in there without any further treatment and shaken up. It has not been shaken much at all, see, the lead settles very rapidly, indicating that practically all the lead is a fair sized particle.

In the early stages of the examination we made microscopic observation of official samples of Electric Storage Battery gray oxide, and I have here some microphotographs at sixty diameters, indicating what we found, practically—

Q. These are not the same as Dr. Ewing's?

A. No, sir. These are going to bring out a little different point. These illustrate what could be

seen under the microscope, or what I saw under the microscope.

Q. Was that just the plain E. S. B.?

A. E. S. B. gray oxide, which has been—which has been carefully washed, and the lead oxide that is left on it, I tried to indicate by that bit of yellow color. That is all that is left on the sample. Now, it is important to notice—

Q. What are the large—are those lead pieces?

A. Those large ones are undoubtedly lead.

Q. Yes.

A. It is important to notice that those large pieces of lead are very much eroded and pitted. This large piece of lead in the center here was rotted, you see, and it was washed quite clean (indicating).

There is another material of the same kind. Here is another material of the same kind; piece of lead had been rotted through and through. Here is one that was focused on a little piece that for some reason—occasionally have a little piece that has a little yellow. Now, in the crevices—

MR. MORRIS: May I pause just a moment to offer these collectively as Defendant's Exhibit 181? There are five, so they will be numbered 181-A, B, C, D, and E. There is no 181 flat.

(Five microphotographs produced by the witness Ullmann were marked, respectively, Defendant's Exhibit 181-A, 181-B, 181-C, 181-D, and 181-E.)

THE WITNESS: There is a legend on the back of each one of those indicating what can be seen.

I don't think that I need go into the subject of coagulation of lead by acetic acid at this stage. In one other trial that was held in this

subject there was a good deal of attention paid to that, but we have found that samples of lead in general, for example, lead that you buy in the market, very fine lead, when treated with acetic acid cleans up the lead, of course, cleaning off all the oxide, the little that is there, and then the lead forms a spongy mass. That is a property of lead.

There are some statements in the literature that lead suboxide is indicated, and they are erroneous statements, by the fact that a solution of sugar, a concentrated solution of sugar will dissolve lead oxide, but would not dissolve it out of what was then stated to be lead suboxide. This was thought to be an interesting test, and we examined these samples of official E. S. B. gray oxide by this method. According to that method the specimen of E. S. B. gray oxide is put into a container of some kind and is stirred with a solution of sugar. The lead, of course, is not dissolved and can be determined. This was done with the E. S. B. gray oxide, and we find that the lead from the sugar treatment, which is probably simply a dispersion of  $PbO$ , that the lead found in the sugar treatment agrees excellently with the lead found by analysis. Thus, again, we have pulled lead and lead oxide apart out of E. S. B. gray oxide, the lead oxide corresponding to all the lead oxide that can be found by analysis, leaving no room, as in the other cases, for any, any appreciable amount of any other oxide of lead whatsoever.

I am going over these rather rapidly. Ignitability; I think there is no use going into that. The statement has been made often that E. S. B. gray oxide does not continue combus-

tion when heated in air at one spot by the approach of a match.

As to reactivity, the reactivity is a measure of the fineness of particles in these related oxides, and we measured the reactivity of Electric Storage Battery gray oxide and that of the oxalate oxide made by heating lead oxalate in which the particles are admittedly very fine. We did this by exposing the samples at 165 degrees centigrade, which is about the temperature of the E. S. B. mill, I am told, and we find that the reactivity thus in air and against oxygen in the oxalate oxide is about fifty-seven times as great as that of the E. S. B. gray oxide. This has a direct relation to the fineness of the particles. We have done this a number of times, and I have here a table on which is a curve showing the gain in weight of oxalate oxide and E. S. B. gray oxide when exposed to air, ordinary laboratory air, at 165 degrees centigrade, which is about the temperature of the E. S. B. mill.

(The witness produced the curve.)

MR. MORRIS: I offer the graph in evidence as Defendant's Exhibit 182.

(Graph showing gain in weight of oxalate and gray oxide when exposed to air at 165 degrees C, produced by the witness Ullmann, was marked Defendant's Exhibit number 182.)

THE WITNESS: In our research covering all physical and chemical methods that we might use to identify this material we would naturally think of one that is one of the great constants of nature, and that is the heat of reaction, and we carried through determinations of the heat of re-

action of E. S. B. gray oxide with acetic acid. This was done with the usual great precautions. I have here a drawing of the apparatus in which it was done. I have here a full description of the methods by which the apparatus was standardized. It was not only standardized against chemically pure materials, but was also standardized through the reaction of hydrochloric acid and potassium hydroxide, by the well-known methods and standards established by the greatest authority on that subject, Theodore William Richards, of Harvard, and we have heats of reaction together with the tabulations all tabulated here, there is no use taking the time of the Court, and we have here the heats of reaction of the official samples, and these show that the heat of reaction of E. S. B. gray oxide corresponds to the heat of reaction that would be expected from the solution of a like amount of  $PbO$  in acetic acid, thus showing that the E. S. B. gray oxide is made up of lead oxide which in its heat of reaction corresponds very accurately with the heat of reaction reckoned according to the analysis.

We have conducted some other experiments, as follows: While we had no faith that we could form lead suboxide by heating together lead and lead oxide, for the reasons that we did not believe in the existence of lead suboxide, we nevertheless heated lead and lead oxide at various temperatures, heated them together at various temperatures from 150 degrees centigrade to 350 degrees centigrade, in twenty-five-degree stages. Those samples were then given to Professor Anderson to see if he could discover anything new in these samples, or if he could discover anything



to which might be ascribed lines which might correspond to a substance  $Pb_2O$  or any other new substance, and he found none.

We also carried on the oxidation of lead. If lead is heated with oxygen we would expect, if a suboxide could be formed, that we would get it at various temperatures, and we heated up until it was oxidized, about fifty per cent. of  $PbO$  and fifty per cent. lead, and we gave those samples to Professor Anderson to see if he could find anything unexpected in them, that would not be expected by any good chemist, and he did not, I understand, he told me, at least, he did not.

We furthermore reduced lead oxide with carbon monoxide,  $CO$ , thinking that in that way we might possibly make some lead suboxide, if such a compound were possible. We naturally did this, because it is supposed that one of the products of heating lead oxalate is  $CO$ . Those products were given to Professor Anderson, and he found nothing which would in any way indicate lead suboxide.

I should now like to turn to the question of fineness.

MR. BETTS: Your Honor, I did not want to interrupt while the witness was heading, but I think we should move to strike out that part of his testimony that refers to what he gave to Dr. Anderson and what Dr. Anderson reported to him.

THE COURT: The only trouble is, they will call Dr. Anderson back.

MR. MORRIS: I have no objection to that part going out. Dr. Anderson has testified, so no objection to the motion.



THE WITNESS: The last time I said, at least he told me so.

MR. MORRIS: Yes.

THE WITNESS: All right.

MR. MORRIS: That is just a little against our rules of evidence, Doctor.

THE WITNESS: Yes, sir.

MR. MORRIS: So I consent that that part be stricken out.

THE WITNESS: All right, sir. I can read some of this.

E. S. B. gray oxide is not an extraordinarily fine product as industrial products go. It is not nearly as fine as the oxide from the decomposition of lead oxalate, Berzelius' so-called "suboxide", which, as I understand it, is the degree of fineness aimed at—although I am no patent expert—in the Shimadzu patent oxide, and which, I believe, is the degree of fineness claimed in a scientific paper by Mr Shimadzu. I refer, of course, to a paper he delivered before a congress.

Now, the great variance of the fineness of E. S. B. gray oxide from Berzelius' so-called "lead suboxide", is evident from its correspondingly lower reactivity, about 57 to 1, as shown by the data and curve introduced under the heading "Reactivity", which has been marked as an exhibit. The comparatively low grade of fineness of E. S. B. gray oxide as compared with Berzelius' so-called "suboxide" is also evident from comparison of microphotographs of the two products, which were submitted by Dr. Ewing.

E. S. B.' gray oxide contains sixty-five per cent. of  $\text{PbO}$  as very fine particles, as seen in the microphotographs, and this would be expected of the normal product made by the reaction of  $\text{Pb}$  plus  $\text{O}$  equals  $\text{PbO}$ , when the  $\text{PbO}$  powder formed is rubbed off in a mill by attrition against lead balls or against masses of previously formed  $\text{PbO}$ .

Could I get Mr. Clocker or someone just to read this for a while?

THE COURT: Yes, sure.

MR. MORRIS: Now that there has been a pause, I should like to have your pages in dealing with the heat of reaction read into the record, or taken from your notebook and put in, unless they are put in.

THE WITNESS: There is a tremendous—there is a good deal of the description. I would be very glad to submit—

MR. WHITCOMB: Why isn't it all right to put them in as a written description?

THE COURT: I think it would be all right.

MR. MORRIS: Then I will get you to separate those after you conclude, if you will, Dr. Ullmann.

THE WITNESS: I will. Do you want the standardization by the method of Theodore William Richards, and all that?

MR. MORRIS: Yes, I would like to have your heat of reaction in the record.

THE WITNES: Very well, all right, sir.

(Mr. Edwin T. Clocker then read from the written report of the witness.)

MR. CLOCKER: The metallic lead particles in E. S. B. gray oxide are in general not as fine as the accompanying  $\text{PbO}$  particles. This is apparent at once on looking at them under the microscope or on the microphotographs of gray oxide; or by looking at the lead particles obtained by washing away of the very fine particles of adhering  $\text{PbO}$ . The metallic lead particles are, however, of distributed sizes to be expected normally of a process proceeding in an orderly fashion by oxidizing the surface of lead balls in a rotating mill according to accepted principles of chemistry, lead plus oxygen—

THE WITNESS:  $\text{Pb}$  plus  $\text{O}$ .

MR. CLOCKER: —  $\text{Pb}$  plus  $\text{O}$  equals  $\text{PbO}$ , with excess of air at an elevated temperature. As the oxygen in the excess air attacks the surface of the lead balls it unites with lead in quite normal fashion to form lead oxide,  $\text{Pb}$  plus  $\text{O}$  gives  $\text{PbO}$ . In doing so it pits and rots the metallic balls, forming innumerable crevices, which often still contain the very fine yellowish colored red variety of tetragonal lead oxide. Lead balls taken out of the mill show some deep, larger crevices visible to the naked eye and often still filled with adhering lead oxide.

THE WITNESS: We have an exhibit at this point of a lead ball cut in two, which shows how active and deep and irregular this pitting can be. It is not very bright, I am sorry, it should be brighter. See those streaks of lead oxide

running down into the ball? That is a regular ball out of the mill.

(The witness produced half of a lead ball.)

MR. MORRIS: I offer that in evidence, 183.

(Half of lead ball, produced by the witness Ullmann, was marked Defendant's Exhibit number 183.)

MR. CLOCKER: These crevices are formed in all directions and the finer pieces of lead eroded and breaking away by impacts in the mill still show further pitting and rotting and are a striking sight under the microscope.

When the oxygen of the air attacks the lead balls rolling in the mill, it does so molecule by molecule. If a group of comparatively few molecules is attacked it is to be expected that a group near the outer surface of the lead ball or a group at the surface of the innumerable crevices and branch crevices will be broken away, with a protection coating of  $\text{PbO}$  which, though porous, would protect for some time the group of molecules from complete annihilation by the attacking oxygen of the air. This group of molecules would be of varying sizes, and might initially have been of such small size that only a comparatively few molecules would be left in the original particle. This might well finally leave the metallic lead particle of very small size indeed, when it is recalled that a molecule of lead is so small that if all the people of the United States were put to picking a pound of lead to pieces at the rate of a molecule per second, it would take them about two million times as long as the period of time from the discovery of

America to the present time. If the original particle of metallic lead broken off with some protective coating of  $\text{PbO}$  were not large enough to withstand the attack of the air and still keep some of its original lead, it would of course entirely disappear as lead and be present as lead oxide.

#### FINENESS BY ATTRITION AND SMUDGING.

Lead is a ductile metal and when a metallic lead surface is rubbed ever so gently over a bit of soft suede leather or a bit of paper very fine particles of lead are smudged off as can readily be seen under the microscope and these are of very small dimension, some of them requiring magnification of a thousand diameters in the microscope to make them visible.

The simple, homely reproducible experiment of rubbing the finger over a fresh leaden surface and carrying off a smudge of any degree of fineness is well-known. We have performed experiments showing the smudging of fine lead over a white paint pigment like Titanox. In the same way the fine particles of lead would leave an admixture of finer metallic lead smudge in the  $\text{PbO}$  produced in the E. S. B. gray oxide process. These very fine blue black particles of lead intimately mixed with the very fine particles of yellowish  $\text{PbO}$  would produce the well-known olive green gray shade of E. S. B. gray oxide. A well-known method in X-ray analysis is to grind a ductile substance like lead with flour to dilute it and attain finer particle size.

Much of this very fine lead rubbed off on the  $\text{PbO}$  present would be oxidized to  $\text{PbO}$  and

added to the total amount of  $\text{PbO}$ , but a portion of the very fine particles which still contain many millions of molecules of metallic lead and are not initially of single atomic or molecular dimension, would survive and appear in the product.

It is thus apparent that the varying degrees of fineness of metallic lead as found in E. S. B. gray oxide follow in harmonious steps quite logically in accord with recognized principles of chemistry, namely: Oxidation of lead with pitting,  $\text{Pb} + \text{O}$  gives  $\text{PbO}$ ;

Reduction of size of particles to smaller particles by continued surface oxidation,  $\text{Pb} + \text{O}$  gives  $\text{PbO}$ ;

Diminution of particle size by smudging the very fine particles of  $\text{PbO}$  present.

**THE WITNESS:** That means by smudging against the very fine particles; it means rub off.

**MR. CLOCKER:** The foregoing steps to account for varying fineness of metallic lead in E. S. B. gray oxide fully satisfy the mind and are based on reproducible experiment, reproducible for any amount of product great or small, and reproducible for every step in the process.

Although these steps exhaust the possibilities of process and product in the writer's experience, and opinion, it nevertheless becomes important to examine claims made by the plaintiff of steps in process and product involving the assumption, wholly gratuitous unfounded in the writer's opinion, of an intermediate substance so-called lead suboxide  $\text{Pb}_2\text{O}$ , together with claims of its activity in an assumed reversible

reaction, out of harmony with established concepts of chemistry.

THE WITNESS: Do we want to discuss the reversible reaction,  $\text{Pb}_2\text{O}$  equals Pb plus  $\text{PbO}$ ? There is no need of writing that on—

THE COURT: Whatever you think.

MR. MORRIS: You may proceed, Dr. Ullmann.

MR. CLOCKER: The reversible reaction,  $\text{Pb}_2\text{O}$ , that gives Pb plus  $\text{PbO}$ , and reversed upon itself. The plaintiffs so-called "harmony" is based on the reversibility of this reaction on the supposition that an equilibrium can exist like  $\text{Pb}_2\text{O}$  which gives Pb plus  $\text{PbO}$ , and the reverse. The equilibrium is impossible. If the compound  $\text{Pb}_2\text{O}$  is assumed it might be imagined to break down into Pb plus  $\text{PbO}$ . Since, however, Pb and  $\text{PbO}$  are both solids, the molecules cannot come into sufficiently close union with one another to combine chemically. If this reverse reaction Pb plus  $\text{PbO}$  giving  $\text{Pb}_2\text{O}$  cannot take place, the reaction  $\text{Pb}_2\text{O}$  giving Pb plus  $\text{PbO}$ , in reverse, can proceed in but one direction, and that is  $\text{Pb}_2\text{O}$  giving Pb plus  $\text{PbO}$ , the reaction becomes monomolecular and all discussion of harmonies based on the equilibrium due to reversibility of reaction falls to the ground.

MR. WHITCOMB: If Your Honor please, we did not claim there was any reversibility whatsoever.

MR. MORRIS: With that concession, which I confess that I thought they had contended just the contrary, you may leave anything else that



you might have had in mind to say with regard to reversibility wholly unsaid.

By MR. MORRIS:

Q: Will you pass to the next point, please, Dr. Ullmann? Don't deal any further with the reversibility in any way.

MR. CLOCKER: Lead suboxide  $Pb_2O$  under the periodic law.

A compound  $Pb_2O$  is impossible under the periodic system and periodic law of the elements, and one of the best established laws of chemistry, and Pb under the system and law, and in the experience of chemists has a valence of 2 and 4, never of 1, lead suboxide,  $Pb_2O$ , would assume that lead has a valence of 1, all the tenets of the periodic law are against a valence of 1 for lead, hence lead cannot exist as  $Pb_2O$ .

Modern theory of electrones is also in agreement with the periodic system assigning a valence never less than 2 to lead.

So-called lead suboxide ( $Pb_2O$ ) and its reaction with acetic acid.

The plaintiffs' testimony contains an equation in which  $Pb_2O$  reacts with acetic acid to form lead diacetate  $Pb(C_2H_3O_2)_2$ . The equation does not equate or balance. It will not balance—

THE WITNESS: I would like to say here that is undoubtedly an oversight on the part of Dr. Clark, but when any court refers back to that equation he will have to recognize that it does not balance.

THE COURT: That is the one he wanted to insert one oxygen in.

THE WITNESS: Yes, sir.

MR. MORRIS: You are speaking now of Defendant's Exhibit 1.

THE COURT: Yes, he agreed to that. Everybody agrees to that.

MR. MORRIS: Very well.

By MR. MORRIS:

Q. It is Defendant's Exhibit 1 that you are referring to?

A. Yes, sir, I imagine so—yes.

MR. CLOCKER: It will not balance written for a reaction of  $Pb_2O$  with acetic acid, and will only balance if written for a reaction with acetic acid and oxygen. Under all laws of chemistry the equation with acetic acid must be written to form mono acetate.  $Pb(C_2H_3O_2)_1$ ,  $Pb_2O$  plus  $2HC_2H_3O_2$  gives  $2Pb(C_2H_3O_2)_1$  plus  $H_2O$ .  $Pb(C_2H_3O_2)_1$  is unknown, admittedly so by the plaintiff, and hence  $Pb_2O$  must be classed as unknown.

The corresponding suboxides  $Cu_2O$  and  $Ag_2O$ , both having cuprite lattice structure are known, and the corresponding mono acetate should be known as they as they should be known in the case of  $Pb_2O$ . The copper and silver mono acetate are indeed well-known chemical individuals, reproducible by anyone, and react forming a mono acetate just as  $Pb_2O$  would if it could exist.

$Cu_2O$  plus  $2HC_2H_3O_2$  gives  $2Cu(C_2H_3O_2)_1$  plus  $H_2O$ .

$Ag_2O$  plus  $2HC_2H_3O_2$  gives  $2Ag(C_2H_3O_2)_1$  plus  $H_2O$ .

$\text{Pb}_2\text{O}$  if it exists must be reproducible by other chemists skilled in the art.

It is a principle of all branches of modern science that experiments by humans to be accepted must be reproducible. All efforts have failed by the writer and his colleagues to reproduce  $\text{Pb}_2\text{O}$  in thirty per cent. concentration or in any concentration by heating lead oxalate at three hundred and ten degrees during four hours—

THE WITNESS: I am just trying to save time and cut out whatever—

MR. CLOCKER: Discovery of a supposedly new chemical individual must be established beyond reasonable doubt.

A new chemical individual before being received into the family of chemical products must have its identity established beyond a gratuitous assumption.

To recapitulate, the equilibrium with the reversible reaction  $\text{Pb}_2\text{O}$  giving  $\text{Pb}$  plus  $\text{PbO}$ , and the reverse, and the plaintiffs' inference from it are not in harmony—

MR. MORRIS: No, that comes out. I don't want any more about reversible reaction.

THE WITNESS: I beg your pardon.

MR. WHITCOMB: We say that the lead goes to lead suboxide and then to oxide, and that the lead suboxide once formed dissociates, so I don't want to confuse it, we have not said that that is not but I thought he meant after dissociation it is reversed and then goes back again. I was just trying to save the record.

THE WITNESS: I thought you said it was an equilibrium.

MR. MORRIS: I don't know where the plaintiff does stand.

THE WITNESS: I beg your pardon, if I may break in, sir,  $Pb_2O$  was in equilibrium with  $Pb$  and  $PbO$ —

MR. MORRIS: They have said they do not contend there is any reversible reaction.

THE WITNESS: All right.

MR. MORRIS: That ends it for us.

THE WITNESS: Point number one then, we will change these.

MR. CLOCKER:  $Pb_2O$  is in conflict with the periodic law.

$Pb_2O$  is in conflict with the action with acetic acid.

$Pb_2O$  is in conflict with the law of science that an accepted experiment must be reproducible.

$Pb_2O$  to be accepted as a chemical individual must be established chemically and physically beyond a reasonable doubt.

On the other hand, all the established facts and reproducible experiments are fully and satisfactorily explained under accepted facts and principles of chemistry if the chemical action in the mill is  $Pb$  plus  $O$ , giving  $PbO$ , and any residual lead thus unacted on remains as metallic lead of varying degrees of fineness. This view is in complete harmony with all and every experiment that the writer and his colleagues

could conjure up as having a bearing on the composition and character of E. S. B. gray oxide.

These experiments give results easily reproducible for the additive character of Pb and PbO in E. S. B. gray oxide and fully and squarely meet—

MR. YAMAOKA: If Your Honor please, we object to this. This is rather an argument, rather than testimony.

THE COURT: Well, I know, but I have permitted that.

THE WITNESS: We will omit that. I thought it was simply an opinion. I should like, then, to recapitulate the various headings, and then subside.

MR. CLOCKER:

1. Color.
2. Specific gravity.
3. Mechanical separation of constituents, also sieving and floating.
4. Amalgamation of metallic lead.
5. Microscopic observation and microphotographs.
6. Coagulation of spongy lead.
7. Solubility of PbO in sugar solution.
8. Ignitibility.
9. Reactivity.
10. Heat of reaction.
11. Reducibility with CO, H<sub>2</sub>, oxidation of Pb.

THE WITNESS: We have gone a little further into the matter about reproducibility, and heated lead oxalate at 310 degrees for two hours in a vacuum. We have then examined the product re-

maining. We find that this product contains 38.3 to 38.8 per cent. of undecomposed lead oxalate.

By MR. MORRIS:

Q. That is after the treatment for two hours?

A. For two hours.

Q. At 310 degrees, under a vacuum?

A. At 310 degrees, under a vacuum.

DR. CLARK: C. or F?

THE WITNESS: C., of course.

By MR. MORRIS:

Q. Centigrade?

A. That is three hundred centigrade. This product was examined by X-ray experts, with X-ray expert Professor Anderson, and was found to contain besides lines for Pb and PbO the lines recorded by Dr. Clark and by him described as lines for so-called—

MR. WHITCOMB: I think we ought to object to this, again, Your Honor. We ought to draw some line.

By MR. MORRIS:

Q. Do you mean, now, that that is what Dr. Anderson testified to in this case?

A. Yes, sir.

Q. And you are referring only to the testimony as given by Dr. Anderson.

A. Yes, sir.

Q. All right.

A. Dr. Anderson said—

Q. Well, what I want—

A. I see.

Q. — to have in mind, Dr. Ullman,—

A. Yes, sir.

Q. — if you will, please, sir, is to confine your testimony to a reference to the testimony as given by Dr. Anderson with respect to that matter.

A. I thought that had been covered by Professor Anderson.

Q. I think it has, but just in order that we may understand you, I simply wanted to know whether you were merely making a reference to Dr. Anderson's testimony with respect to that, for the purpose of identifying his testimony with the sample about which you are now testifying.

A. Oh, yes, sir.

Q. All right.

A. That is all.

Q. You may proceed, Doctor.

A. The residæ left after heating for two hours at 310 degrees centigrade under vacuum, of course, contained other substances, lead, and lead oxide. The lead and lead oxide were removed from the oxalate and the lead oxalate further identified as such. The lead oxalate was identified by two tests. Part of it was heated in the air and turned red, as would be expected from lead oxalate.

Another portion was heated in a vacuum and turned black, as would be expected from lead oxalate. The portion which had turned black was then taken out, and on further heating in the air turned the well-known color yellowish-red, which is the result of heating lead oxalate in the air.

Furthermore, this lead oxalate would be insoluble in acetic acid, I think as I have indicated, and lead oxide might be dissolved away from it. The lead, of course, could be driven away very



easily, because it is fine lead, in this case by simply running a stream of oxygen over it at ordinary temperature, in the presence of a little moisture.

In order to further identify the original lead oxalate it was heated for a greater length of time until we got a hard vacuum—I will explain that in a moment—until we got a hard vacuum, and was then found to consist wholly of lead and lead oxide.

The method by which we determined the decomposition of the lead oxalate was as follows. The lead oxalate was subjected to vacuum, and as long as gas was given off the decomposition had not been completed. We determined whether or not gas was being given off by a high frequency current by the instrument ordinarily called a leak finder, which will tell whether there is any gas in an evacuated tube still being given off.

Now, if I may give an opinion as to the bearing of that on E. S. B. gray oxide I would say that what has been done is to take the lines which in my opinion were wholly the lines of lead oxalate and lead oxide, and because lines like them were found in E. S. B. gray oxide, to say that the lines of lead oxalate prove that E. S. B. gray oxide contained lead suboxide.

By MR. MORRIS:

Q. You mean that is your conclusion?

A. Yes, sir.

Q. I don't understand you, Dr. Ullmann.

THE COURT: He thinks that is what Dr. Clark did.

MR. MORRIS: That is what I assumed he meant, but I didn't think the record was clear on it.

THE COURT: Oh, I think it is.

MR. MORRIS: Very well.

By THE COURT:

Q. You think that is Dr. Clark's error?

A. Yes, sir.

Q. Yes.

A. It must have been.

By MR. MORRIS:

Q. You may proceed, Doctor.

A. In other words, Your Honor, I conclude it was wholly a non sequitur.

The question by you, sir?

Q. I have no question, unless you are through.

A. Yes, sir, I am through.

Q. What have you to say about the Toronto product? You have mentioned the defendant's gray oxide. Have you anything to say with respect to Dr. Wilson's sample of the Toronto product, how it compares, whether you made any examination of that, what it contained, and how it resembled and how it differed from the E. S. B. gray oxide, as briefly as you care to make it.

A. Well, we made examinations of that product, of course, for density, not to the final method that we had for amalgamation, but previous methods of amalgamation; a microscopic examination was made, to which Dr. Ewing has testified; made examinations of results of sugar treatment, sugar solution, official samples. Of course, we tried ignitibility, as everyone does. We made tests of reactivity by exposing the sample to air. We made tests of—we made tests of heat of reaction, I remember. I didn't put them down here.

Q. Did you find any  $Pb_2O$  in it?

A. No, sir.

Q. Will you summarize briefly the differences between the E. S. B. gray oxide and the Toronto product, official samples as taken by Dr. Wilson on January 11, 1935, first as to color?

A. The color was darker.

Q. Darker?

A. Yes, sir.

Q. What does that mean, if anything, Dr. Ullmann, with respect to the physical distribution of the ingredients of the two oxides?

A. It would indicate there was a preponderance of the color of the lead. The lead was probably on the outside in that case.

Q. In the Toronto product?

A. Yes.

Q. Well, in the gray oxide, the E. S. B. product, what would the gray-olive, or olive-gray color indicate to you with respect to the respective distribution of the oxide and the lead in that product?

A. The olive-gray color would indicate that the yellowish  $PbO$  lead oxide was outside.

Q. On the outside of the particles?

A. Yes, sir.

Q. What was the percentage of lead in the Toronto product, if you have it?

A. Toronto product, if you want the names of them—percentage of lead was 27.7; another one of the samples, 27.6; another one, 28.2 lead; another one, drum sample, 26.3 lead.

Q. And what did you find the remaining portion of that Toronto product to be?

A.  $PbO$ .

Q. I don't recall whether I have asked you in the

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last two minutes whether you found any  $\text{Pb}_2\text{O}$  in it or not.

A. We found no  $\text{Pb}_2\text{O}$  in it.

Q. You found no  $\text{Pb}_2\text{O}$  in it. What difference, if any, did the physical distribution of the two ingredients make in the reactivity of the Toronto product compared with the gray oxide manufactured by the defendant at Philadelphia?

A. The Toronto product would be expected to be more reactive, as it is.

Q. Because the unconsumed lead is more exposed?

A. Yes, sir.

MR. MORRIS: All right, you may cross-examine.

By MR. MORRIS:

Q. Oh, will you take out for me, please, your sheets with regard to heat of reaction?

A. I have a chance to go over them and correct them?

Q. Well, won't you do that, then?

A. I mean, they are nearly correct, anyway.

THE COURT: I have to make a phone call some time this afternoon. I guess this is as good a time to do it as any. Suppose we recess.

---

(Recess at 3.15 o'clock P. M.)

---

HARRY M. ULLMANN, recalled.

MR. MORRIS: I offer in evidence, as the Defendant's Exhibit 184, Dr. Ullmann's heat of re-

action testimony and experiments—there are a number of them—pages 71 to 85, inclusive.

THE WITNESS: Judge, may I make a statement about the testimony? That can't go in an exhibit because there's a lot of that stuff, conversely, in there and it's not in my testimony. If you don't mind, I will edit it a bit.

MR. MORRIS: All right. I will withdraw the offer.

MR. WHITCOMB: Well, we wanted that in; that's what he was reading from, wasn't it?

MR. MORRIS: No.

(Discussion off the record.)

MR. WHITCOMB: All right, sir.

*Cross-examination.*

By MR. WHITCOMB:

Q. As I understand it, you made some amalgamation tests with mercury—

A. Right.

Q. —and that brought down the lead and the residue. Did you save the residue?

A. Yes, sir. The residue came out. It's the only little step I omitted, and if you would like to know exactly that little step: In order to separate mercury from the oxide, another material, we did the customary thing, and that is we filtered it, and the effective method of doing that is not the usual method but one employing the thicknesses of cheesecloth. It is filtered through the cheesecloth, you know, and the mercury squeezed out, which brings the other materials not amalgamated on the cloth.

Q. Did that leave the lead oxide?

A. Yes, sir.

Q. What did you do with that?

A. Why, we proceeded—it was soluble, that is, the black material itself was soluble in acetic acid.

Q. Well, the black material—is lead oxide black?

A. Oh, it was—whenever you mix any materials with mercury and shake them, the very small globules of mercury distribute in the material and it gets a dark color, like that. There's some of the mercury in lead distributed in there.

Q. Just a minute, maybe you didn't understand what I mean. You started with a sample of Exide oxide—

A. Yes, sir.

Q. —and you amalgamated it with mercury?

THE COURT: I will answer for him. He just nodded his head.

By MR. WHITCOMB:

Q. Yes. And the mercury took up the lead?

THE COURT: Yes.

By MR. WHITCOMB:

Q. Did you retain all the rest of the sample from the gray oxide mill that you used in that particular experiment with the mercury?

A. No, sir, we didn't retain all of that because it is usually spread on the cheesecloth and stuck to it.

Q. Then you don't know what percentage—what the percentage of oxide was? You only got the lead out by that process?

A. Yes, sir, that is right.

Q. Then, so far as there being any lead suboxide, you don't know what happened to the oxide end of it?



You only know you got so much lead out of it? That's right, isn't it?

A. Yes, sir.

Q. Then you made an acetic acid test, did you not?

A. That wasn't a test. We simply dissolved it in the acetic acid, which—

Q. Now, that was another sample entirely? You took another sample of the Exide material and ran the acetic acid test?

A. Not in connection with this, no, sir.

Q. You didn't make any acetic acid test?

A. Not in connection with this. In connection with this, we made many acetic acid tests, you also do that when you analyze. In this connection, in order to make doubly sure, we didn't determine the lead by difference—determine the lead in the original—

By THE COURT:

Q. Naturally, actually weighing the lead sulphate from it?

A. Yes.

By MR. WHITCOMB:

Q. At no time, as I understand your testimony, then, have you attempted to figure the percentage by a chemical method—of the PbO, for example—that may be in the Exide mill?

A. Oh, yes; many times.

Q. Well, how did you do that?

A. Why, we dissolved the PbO in acetic acid.

Q. Where did you get the PbO?

A. PbO—out of the E. S. B.—oh, we took the whole sample.

Q. And that had some lead in it?

A. Yes, sir.

Q. And then what did you do?

A. Treated that with acetic acid.

Q. And then, if acetic acid dissolves  $Pb_2O$ , then you dissolved that, too. Is that right?

A. If acetic acid dissolved  $Pb_2O$ , and if there was no  $Pb_2O$  present, I don't know whether it would or not.

Q. But your tests didn't distinguish whether there was  $PbO$  or  $Pb_2O$  in the mixture, did they?

A. You mean, the tests with the acetic acid?

Q. Yes.

A. It depends on what the properties of  $Pb_2O$  are.

Q. Assuming that they are both soluble?

A. Yes, sir. If they are both soluble by acid—acetic acid, I mean—

Q. Do you know—

THE COURT: Let him finish.

THE WITNESS: If they both dissolve by acetic acid, they were both completely dissolved.

By MR. WHITCOMB:

Q. You had no way of determining how much of each was in the substance?

A. If you assume the lead suboxide was completely dissolved by the acetic acid—

Q. Let's assume—

A. —if present, it was completely dissolved by the acetic acid. The lead oxide was also completely dissolved by the acetic acid. I could still determine how much  $Pb_2O$ , if you please, and how much lead was present.

Q. Did you do so?

A. No, sir.

Q. Will you do so?

A. No, sir; I can't. I haven't anything to do it with.

MR. WHITCOMB: Of course, your Honor, we contend that he hasn't proven anything about the capacity to determine, just like he started out with—that there is no chemical way of determining, in a mixture of, say, lead suboxide, if it exists, mixed lead—a mixture of lead suboxide and  $PbO$ . The record has not shown any method whatever of determining whether the  $Pb_2O$  exists chemically.

By MR. WHITCOMB:

Q. Can you explain whether or not you have shown any way?

A. Yes, sir; I can show you a way.

Q. Well, have you, on your direct testimony?

A. No, sir. I have simply said it could be done—the Judge asked me. I think the Judge asked me, and I said it could be done.

Q. Well, please explain how it could be done then?

A. Well, if your Honor would like to understand it, I am afraid I will have to have a blackboard.

THE COURT: All right.

MR. MORRIS: We will have this one.

(Discussion off the record.)

THE COURT: Well, is it really more for Dr. Wilson than anybody else, so you had better come around where you can see that blackboard.

By THE COURT:

Q. Now, what we have in mind, if I have the same

thing that Mr. Whitcomb has, is that you are given a sample, which you are told comes from the Exide plant, and which you are also told the people who give it to you think it consists of lead and lead oxide, and the first thing you do is you can remove all the lead from that sample. Just go back a minute—you take that sample and, possibly, you divide it into more than one part—wait, you had better follow my question. The first thing you do is to divide that sample, we will say, into two or three parts, assuming that it is uniform; then you take one part and, by your amalgam process, you remove all the lead. That's right, isn't it? That's what you do?

A. That can be done, yes, sir.

Q. That's what you did?

A. Yes, sir.

Q. From—all the metallic lead—

A. Yes.

Q. —you removed that by amalgam?

A. Yes.

Q. We will call that portion one of the sample. The balance of portion one you just throw away—you let it go?

A. We had no method—

Q. The fact is,—I'm not asking for an explanation—I want to really start with facts, then we can build it up. The fact was, the balance of portion one you just threw away, you didn't bother with it any more?

A. Yes.

Q. Then you took sample two and, as I understand it, by means of acetic acid tests, or acetic acid process, you dissolved everything in that sample that was not free metallic lead. Is that right?

A. Yes.

Q. And everything in that sample did dissolve except the free metallic lead. That's right, isn't it?

A. Yes, sir.

Q. So that you got from sample number two, you got free lead and you got a solution of something?

A. Yes, sir.

Q. Now, the percentage of free lead, metallic lead, in sample number two, as I understand it, corresponded exactly with the lead that you had removed from portion number one by amalgam?

A. Yes.

Q. You still had your solution that came from portion number two?

A. Yes.

Q. Now, what I would like to know is whether you made any further analysis of that solution to see what it contained?

A. I made no further analysis. We did, in order to check it, make a gravometrical determination of the total lead it contained.

Q. You did that much?

A. Yes, sir.

Q. So that you came to the conclusion that the solution derived from what I am calling portion number two contained lead and something else?

A. Yes, sir.

MR. WHITCOMB: Can I ask him one question?

THE COURT: All right.

MR. WHITCOMB: I was wondering if, in that further test of that solution, he had left over after number one, did he get any more lead?

THE COURT: Now, wait. You are off the track—

MR. WHITCOMB: All right.

THE COURT:—that is, you are off my track. It may not be the right one.

MR. WHITCOMB: All right.

By THE COURT:

Q. In the solution which came from portion number two, you did find lead. Is that right?

A. No, sir. I didn't find any free metallic lead.

Q. No?

A. I determine the lead by analytical methods.

Q. You found lead—any combination of—I don't know how you express it—

A. In the solution, yes, sir.

Q. —you found lead and you determined the amount of that?

A. Yes, sir.

Q. And that didn't tell you anything further. As I understand it, all that told you was that that solution was one of the oxides of lead, or did it tell you more than that?

A. Well, the solution, if you speak exactly, told me it was the second lead present, combined with at least—it went into the solution after treatment with the acetic acid, yes, sir.

Q. Now, did you get any further information about that portion of what I have called portion number two that was in solution?

A. Did I actually get any? No, I did not. But you asked me whether there was a method by which it could be obtained.

Q. I did ask you that, yes.

A. And I told you that there is.

MR. MORRIS: On two assumptions—one that PbO exists and that it will dissolve in acetic acid?

THE WITNESS: Of course. That is understood.

By THE COURT:

Q. Will you go back again? Suppose the sample that had been given you by the Exide people, unknown to yourself and to them and everybody else, contained, let's say, lead and lead oxide and red lead. It could do that in a mixture, couldn't it?

A. I imagine it could.

Q. That's not impossible?

A. Yes.

Q. Could you detect that? Yes. Did the things that you actually did—were they sufficient to show you, for instance, that there was no red lead present in that process?

MR. MORRIS: Your Honor means  $Pb_3O_4$  and not red litharge, I assume?

THE COURT: I am trying to pick out some other oxide of lead.

MR. MORRIS: Red lead is sometimes known as—

THE COURT: Red tetragonal, yes. But, I mean some other.

THE WITNESS: Well, that introduces another complication, if you please.

THE COURT: All right, I am afraid it does. Go ahead.

THE WITNESS: That introduces another complication with the extra atom of oxygen there, which would—



By THE COURT:

Q. But, the point is this: Did you do anything that would show that there was not, for instance, red lead present in that solution? Would red lead have been dissolved the same as  $PbO$ ?

A. I think so, yes, sir.

Q. Well, then, I want to just find out the extent and the value to me of what you did.

A. Yes.

Q. Then, as far as you know, you couldn't testify, for instance, today that there was no red lead in that mixture, could you?

A. No, sir.

Q. Well, then, how can you testify that there is no  $PbO$ ?

MR. WHITCOMB:  $Pb_2O$ .

THE WITNESS:  $Pb_2O$ .

By THE COURT:

Q. Yes,  $Pb_2O$ —assuming that there is such a thing. It's only one of the other oxides of lead, isn't it?

A. Yes, sir. That is a rather peculiar thing, your Honor. In all our experiments, the lead and the lead oxide—determined by various chemical and physical tests—added up to a hundred; as near as you can or as near as can be determined by humans—and that left no room, as far as I am concerned—

Q. Now, wait. That, I understood to be your general procedure?

A. Yes.

Q. Surely. And then, when I come to inquire—I don't know what test you made to show what amount of lead oxide was in the sample.

A. I think I can clear it up, if I say one more thing.

Q. Yes.

A. As we went along, our results—the results we got appealed so much to us as rational persons and rational chemists—were so indicative that our gray E. S. B. oxide was made of lead and lead oxide, that we went no further in our assumption—our examination. And, not until this case came up yesterday, until that matter came up yesterday, did I try to think out a method by which it could be done. And, last night, having a few moments, I wish to say this quite frankly, I thought, “Why you better find some method by which it could be done if that were possible,” and I thought out a method, and I am sure it is right, but I have not had time, since last night, to carry it out.

Q. All right. Well, now, that's within the result, as I understand it—the result of your testimony—and I want to be sure about this: It is solely to the effect, and goes no further, that there was—I didn't mean the result of your testimony, strike that out. The result of your experiments couldn't show there was—couldn't show any more than there was a mixture containing lead and some oxide or oxides of lead?

A. It went further than that, if you please. The physical determinations, and they are very exact, the physical determinations of density and heat reaction accorded exactly, right to the dot, with PbO, known and—

Q. And with nothing else?

A. And with nothing else, unless the PbO should happen to have exactly the same properties as Pb, which is, in the mind of a rational chemist—

Q. That's perfectly clear to me. We start, then, with the proposition that the amalgam experiment alone did not tell you that?

A. The amalgam experiment alone didn't tell me that, but the lead accorded exactly.

Q. That's what I want to know. To get the exact amount, the other fraction of your mixture showed that that accorded exactly with the Pb or the supposed PbO contained. Then you resorted to density and—what do you call it?

A. Heat of reaction.

Q. Yes, heat of reaction.

THE COURT: All right, now. Mr. Whitecomb.

By MR. WHITCOMB:

Q. Now, in connection with the heat of reaction tests, Dr. Ullmann,—

A. Yes, sir.

Q. —you are acquainted with this German journal, "Kolloid-Zeitschrift"?

A. Yes, sir.

Q. That's a recognized standard?

A. It is a regular standard journal, yes, sir.

Q. Now, in the 1934 issue, on page 318, is this paragraph here (indicating), which we have translated to read as follows:

MR. MORRIS: Will you be good enough to compare the German with the translation submitted, Dr. Ullmann?

THE WITNESS: Yes.

MR. WHITCOMB: (Reading) "The energy content of the oxides is higher the lower the temperature and the greater the speed at which it is formed. The forms with richest energy content have molecular heats of solution which are, for example, for zinc oxide 1300, beryllium oxide

1400, magnesium oxide 2500, and iron oxide  $\text{Fe}_2\text{O}_3$  more than 5000 calories greater than the values for oxides with minimum values. It is thus easily shown that the energy-rich oxides possess enhanced catalytic power and chemical activity."

By MR. WHITCOMB:

Q. And I ask you to state if that does not mean that these oxides vary from a minimum to an excess of 5000 calories, in some instances?

A. Yes. Kilogram calories are thousands of calories, and this makes the statement that they vary from 13 calories to 5 kilogram calories for substances made up, of course, wholly of some kind of oxide. I haven't got that yet. Are those colloidal articles? I would have to read—I mean, read the whole article.

Q. Yes, but that particular paragraph, translated as I read it, about being subject to variations—

A. Now, wait. I haven't read this article. It is a very long article, sir. I would have to read it and see what the significance of that is.

THE COURT: Can you show me where, on the Doctor's notes, the density test is referred to? I don't want to put his voice to the strain of going all over it again.

THE WITNESS: Yes, sir. About X-ray analysis—I beg your pardon.

MR. MORRIS: I assume that's it, although my notes aren't the same as his.

(Discussion off the record.)

By MR. WHITCOMB:

Q. Have you ever read this article?

A. No, sir, I have never read this article. I will have to go over it sometime.

Q. But its true that some oxides have a variation in the heat energy content, isn't it?

A. I don't really know whether—it's very important to read that article, as applying in this case, your Honor, because this Friche, who wrote this article, is exactly the same man who said that  $Pb_2O$  should now be stricken from the literature.

Q. Well, but oxides do have—you are talking about a heat test, now, however?

A. But I can't talk about it without considering Mr. Friche's article, because he tells me, before I start, that there is no lead suboxide and; if I am to believe him in one place, I am to put just as much reliance in his as in the other.

Q. I am asking you if you really think there is—

A. I say, I don't know, sir. I will have to read the article.

Q. I mean, of your own knowledge?

A. No.

Q. You don't know?

A. No, I don't know.

Q. If such a matter of five per cent of suboxide in the contents of the material that you subjected to a heat test, assuming that it was, then your heat test wouldn't bring out that differentiation, if it was a matter of five per cent?

A. I don't know whether it would or not. There's nothing said here about the oxide of lead to which you are referring—and this man, Friche, has undoubtedly had a great deal of it. He must have had some of it in the laboratory, but this makes no reference to  $Pb_2O$ .

Q. In this Exhibit 180, offered, where did you get the lead at the top?

A. That particular sample of lead is the fine lead

and is the purest one I could get. I got it given to me, very kindly, by Mr. Hall—but I have done exactly the same thing by lead obtained from Eimer and Amend.

Q. I understood that this came from the oxide samples that were handed to you?

A. No, sir. That's a synthetic mixture to start, with pure lead and the very purest kind of tetragonal lead.

Q. Yes.

A. And you get exactly the color you would expect if it were a nice chemical mixture.

MR. MORRIS: Will you read me the exhibit on the bottom of the box about which you are now speaking?

MR. WHITCOMB: I just did. It's Exhibit 180.

MR. MORRIS: All right.

By MR. WHITCOMB:

Q. Do you think there is free lead that fine in the Exide oxide?

A. I really don't know how fine that lead is. I have never examined it for fineness.

By THE COURT:

Q. Does this density test come down to determine the average density, if you may call it so, of the whole mixture?

A. Yes, sir, the average, with the added density.

Q. The average, with the added density, yes. And, knowing the densities of each component, you then figure, if you get an added density, that's the exact average of the two. You must have those two?

A. You must have those two.

Q. That's about the test, isn't it?

A. Yes, sir. It's like all these other things that we have in science, sir. When everything, chemical and physical, that you can think of points in one direction, why you are forced to that conclusion.

Q. I am wondering about this test. Now, I just—suppose you have two substances; the density of one I don't know—I don't know anything about those units—but the density of one is twenty and the other is ten units, or whatever it may be. You get an average density of the whole thing of fifteen, don't you?

A. If you mixed them in equal proportions, yes.

Q. Yes, if you mixed them equally, in equal proportions?

A. Yes.

Q. Now, you couldn't get that any other way. You couldn't get that any other way. If one of those substances—lead was in it—and, say, that's twenty. You must have the other substance which has a density of ten to make your average?

A. Yes, sir.

Q. Well, suppose that other portion instead of one with a density of ten should consist of two things—

A. Yes. Well, I—

Q. —one with a density of fifteen and the other with a density of five—

A. Mixed in equal proportions?

Q. —mixed in equal proportions, yes—

A. Yes, sir; that would be all right.

Q. Then, you would still get an average density of fifteen for the whole thing, wouldn't you?

A. Those figures are exactly right.

Q. They are not exactly right. I am trying to get them exactly right.

A. If you had an average density of ten, you would.



Q. Yes. If you got an average density of ten out of your part that wasn't lead, you would get the same added density, you call it?

A. Yes, sir; you would.

Q. So that it might consist of three substances instead of two, your total mixture?

A. Yes, it might.

Q. Your density test does not prove that?

A. Hypothetically, it might, of course.

Q. Yes.

MR. WHITCOMB: Dr. Ullmann, —oh, I beg your pardon.

By THE COURT:

Q. Did you say—then, am I understanding—am I to understand that no single one of the experiments that you subjected this mixture was, in itself, conclusive, or is that correct? Am I correct in saying that—that you relied upon the coincidences of all the experiments?

A. I should say it was conclusive. For example, I should say that the heat of reaction, as we go along this whole thing, is conclusive, unless you make assumptions about another compound.

Q. I am taking density now. That test, alone, would you say was conclusive?

A. No, sir. It is merely very highly presumptive.

Q. And cumulative?

A. Yes, sir.

Q. And the heat of reaction test, standing alone, you say it is conclusive?

A. The heat of reaction test? Why, you can make suppositions about that, as you did about the other—that you might have two substances, one on either side. You can do that, of course, with any quantitative result.

Q. I can see, with your density test, that it would be an absolutely conclusive assumption with only two substances in the compound?

A. The chances are, in your heat of reaction test agreeing with the results. I mean, supposing you had three substances in your density test. I don't know what the probabilities are, but I guess it's much less than one in a million.

Q. I know that's the way scientific tests are arrived at.

A. Yes, sir; that is right.

Q. I realize that by the use of various tests, no one of which is conclusive, and you get a coincidence that is so remote to occur by chance—that is too remote to occur by chance—that you come to the conclusion that the fact has been established.

A. Yes.

Q. I realize that, I say.

A. It can be. The chance, if you get a perfect agreement by one method and a perfect agreement with the other, for three substances, the chances are almost like the chance quoted by—well, I won't bring that in—but it was by one of our fine philosophers.

Q. About the chance of the Titanic hitting the iceberg, but they did it.

A. As long as you bring that up, sir—

Q. I think somebody calculated that was about one in three or four billion, I have forgotten how many.

A. —that philosopher said: "That the successive jabberings of successive monkeys going up the Congo might simulate Dante's Divine Comedy."

Q. Well, I know what you are talking about any way.

MR. WHITCOMB: There's one question I want to ask Dr. Ullmann.

THE COURT: All right.

By MR. WHITCOMB:

Q. Do you understand that Le Blanc has shown that there is a substance,  $\text{PbO}$  sub one point one two?

A. Yes, sir.

Q. And, in that case, do your tests differentiate here a substance containing that compound over  $\text{PbO}$ , say, or a mixture of  $\text{PbO}$  with suboxide?

A. To that I would have to respond that, in the same journal which gives us that knowledge, a little later in the journal Mr. Le Blanc makes this statement about lead suboxide—he took the same oxalate oxide and heated it, and he says—I will translate it:

“The solid residue consists of finely divided metallic lead and red oxide of lead. The determination was carried out by microscopic and X-ray methods. Indications of any suboxide  $\text{Pb}_2\text{O}$  could not be found.”

That's the same, as a matter of fact, sir.

Q. But, I am asking about  $\text{PbO}$  sub one point one two, leaving out the suboxide.

A. I must retort to that, sir, that that would have no relation to lead suboxide.

Q. I'm not saying it does.

A. I beg your pardon, sir, because that's the same man, who—whom am I to believe. See? If I believe him there, I must also believe him here. And it does not apply to lead suboxide because he says the lead suboxide could not exist.

Q. I am asking you how that would affect your tests if the substance actually had  $\text{PbO}$  sub point one.

two, instead of  $\text{PbO}$ —your density tests, your heat of reaction tests?

A. I can't permit myself, sir, to logically reply to that, because that would not be a chemical individual. When it becomes a chemical individual, it should have the composition—the lowest composition it could have would be  $\text{PbO}$ —and what I mean by chemical individual is the kind of thing according to which we buy and sell any patent.

MR. WHITCOMB: Well, of course, that doesn't answer the question. I wish—shall I press it further?

THE COURT: As you like. You see, I have lost—this heat of reaction test is the one—maybe I can find out something about it—but that's the one I didn't think it was necessary for me to understand because he says it's on the same footing.

MR. WHITCOMB: The same footing as the other?

THE COURT: Yes.

MR. WHITCOMB: But we are trying to take it and speak further, your Honor, to show that if he had a substance recognized as  $\text{PbO}$ —

THE COURT: Hasn't he already said all you want? That is to say, that the heat of reaction test is the same basis as the density test, and that there might be—that the balance, after you take the lead out—that the balance might be two substances?

MR. WHITCOMB: Yes.

THE COURT: And a compound of two sub-

stances which would give him the same result as the lead oxide.

MR. WHITCOMB: Cross-examination closed.

(Discussion off the record.)

MR. WHITCOMB: Could we ask him one more question?

THE COURT: Yes.

By MR. WHITCOMB:

Q. Did you actually conduct these tests that you have testified about yourself?

A. Well, do you mean, did I do all of them with my own hands?

Q. Yes.

A. No.

Q. Well, any of them?

A. Yes, some of them. I was in the laboratory regularly.

THE COURT: Well, I will assume that he had supervision enough over them to testify that they were his own.

By MR. WHITCOMB:

Q. Then, we wanted to ask how many grams of lead oxalate did you use in the decomposition test?

A. Why, in the decomposition test—oh, that would weigh forty grams—the amount of lead oxalate we used. I can't tell exactly, but there was about that much—that's in an Erlenmeyer flask.

(Discussion off the record.)

MR. WHITCOMB: If you don't mind, there's one more question, following that, about the amount he used.

THE COURT: All' right.

By MR. WHITCOMB:

Q. If you had an exceedingly thin layer of lead oxalate and heated it in a bowl at 310 degrees C., as you testified about, is it likely that the decomposition might be complete?

A. Not in two hours.

MR. WHITCOMB: That is a l.

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HAROLD V. ANDERSON, recalled.

*Ré-direct-examination.*

By THE COURT:

Q. Dr. Anderson, I don't know whether your experiments put you in a position to answer this question or not. I really intended it for Dr. Davey, but let's see if you can help us with it. The examination you made by the X-ray machine of the sample gave you lines of lead, as to which there was a very close correspondence with Dr. Clark's lines?

A. That's in the gray oxide?

Q. Yes.

A. Yes.

Q. And it also gave you the lines of tetragonal litharge?

A. That's right.

Q. Which corresponded very close y with Dr. Clark's lines?

A. And also with the so-called theoretical spacings and the analysis of red  $PbO$ .

Q. Yes. Now, as I understand it from Dr. Davey, it also gave the lines of lead carbonate?

A. There are—according to my testimony, I believe I testified that I found nothing else but lead and red PbO.

Q. Oh, you didn't find any lines of lead carbonate, then?

A. No, I didn't.

Q. Then we can't ask the question I had in mind. You remember he had an illustration that he used, about the partial fingerprint?

A. Yes.

THE COURT: Well, all right. Then, we just can't do it. We will have to just ask Dr. Davey somehow.

MR. MORRIS: Very well.

(Discussion off the record.)

MR. MORRIS: I didn't put in the Wyckoff book, to which reference was made, showing the carbonate lines. It might be that might have a tendency to help your Honor.

THE COURT: No. But I remember it, if you want to put it in. That's the one with the spider web?

MR. MORRIS: No, sir.

THE COURT: Isn't it?

MR. MORRIS: No, sir. I will show you.

MR. MORRIS: Am I going to be supplied with one or two books on this subject, if I promise to read them?

(Discussion off the record.)

MR. MORRIS: On page 274 of this edition of Wyckoff's of 1931, there is this:



MR. WHITCOMB: This is Clark's?

THE COURT: No, he's not talking about that right now. He's showing me where these lead carbonate lines show up.

MR. MORRIS: This edition, 1931, of Wyckoff's, page 274, there's this—the following:  $\text{PbCO}_3$ , orthorhombic. Then, under a sub zero, is the measurement of 5.14, and then, under the c sub zero, there are—under the c sub zero, or alpha, is 6.10. Now, then, that shows the basis of Dr. Davey's testimony.

THE COURT: Well, all right. I will get that from him.

MR. MORRIS: Yes, sir, but I wanted you—I just wanted you—

THE COURT: I am afraid this is a little over my head.

(Discussion off the record.)

THE COURT: All right. Go ahead with Mr. Hall, if you want to.

MR. MORRIS: Mr. Hall, will you take the stand?

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CLARENCE A. HALL, was called as a witness on behalf of defendant and, having been first duly sworn, testified as follows:

*Direct-examination.*

By MR. MORRIS:

I am connected with the Electric Storage Battery Company, the defendant in this case, and have been so

connected since June or July of 1920. I am the same Clarence A. Hall who was in the Interference with the plaintiff in this case, Mr. Shimadzu, in the Interference Nos. 54,798 and 56,224. The testimony, purporting to have been given by me in the copy of that interference record, introduced in evidence as one of the plaintiffs' exhibits in this case, correctly reports my testimony there given, so far as I know. The product of my mill that I was dealing with in that interference, was the lower oxides. It was the lower oxidation products. In my mill we have succeeded in getting an oxidation calculated as litharge as low as twenty per cent and from there up to eighty per cent. Our commercial product is grayish—gray oxide, as shown in the samples here in evidence. The color of those low oxides that I am talking about was very dark gray, much darker than the gray oxide; much lower. In comparison, this is much darker in color than the product we are making in Toronto. I mean, it is darker than the color of our product. The Toronto product is darker than our product. The lower oxides I am talking about are darker than the Toronto product. That's right.

I am the same Clarence A. Hall who is the patentee in United States Patent to Hall, No. 1,675,358 and also in the patent to Hall, Clarence A. Hall, No. 1,888,823. I first put a cyclone on my mill or what has been referred to here as the Hardinge Mill two or three months after we started in January, 1921. Mr. Davey yesterday or the day before testified that he had received some lead balls from me and that he had made certain analyses with respect thereto. His testimony in that regard is correct. The balls were marked by drilling a large hole in them so as to identify them, and they were placed in the mill early Monday morning when the mill was cold.

MR. WHITCOMB: Does Mr. Hall say he got them from the mill?

THE COURT: Sure.

MR. WHITCOMB: That's all right, then. There's no dispute on that.

The witness, resuming, testified: I put them in at the feed end of the mill when the mill was cold on Monday morning and started operations, and when the temperature got up to 175, I stopped the mill, and there were a few balls still up there at the feed end. They were picked out with tongs and put in cans filled with nitrogen. We stuck the tongs down in the mill and put them in the can, and they were—then they were sealed up. They were identified by the hole I drilled in them before I put them in. The apparent specific gravity of the lower oxides produced by me from time to time, with respect to which I testified in Washington, was either 2 or  $2\frac{1}{4}$ , or something of that sort, as near as I can recall.

THE COURT: Which one—150?

MR. MORRIS: Yes, sir. Beginning at about fifty or fifty-five.

THE COURT: All right.

The witness, resuming, testified: the black powder was chemically reactive. It was spontaneously converted into litharge by exposing it to air. Many times the drum caught fire when the material was fed into it. It would sometimes catch fire. If a drop of water was dropped on a pile of my black oxide, that would start reaction. It would continue. The pile commenced to oxidize until finally the whole thing oxidized. It changed color. If you applied a lighted

match to a pile of it, it would burn, and it would continue to turn until it was all burned up. The oxidation started by the application of a match or a drop of water on the pile would continue until substantially all of it was converted into litharge. The gray oxide, as manufactured for commercial purposes by the defendant since 1924, will not burn if a lighted match is applied thereto. If a drop of water is applied to it, it would make mud. We can make black oxide with our present set-up. We can make anything we want. That was my original contention. We have made the lower oxides. The result of those interferences appears in the decision of the Court of Customs and Patent Appeals, filed June 20, 1932, and reported in 59 Federal Second 225.

MR. SCHAFER: We object to that. The decision speaks for itself. There's no use to have this man interpret it.

MR. MORRIS: This man is identifying it.

THE COURT: There's no use spending two minutes on either the question or the objection.

MR. MORRIS: He's merely identifying it as the decision in this case, and that has been done by my question and his answer.

THE COURT: All right.

The witness, resuming, testified: The date on which the bag collector was annexed to my machine or first installed was some time in June or July, as near as I can recall, '21. Referring to Defendant's Exhibit number 47, this is the bag collector that we bought from the Sturtevant Company after I had tried to make a lot of home-made things and didn't

succeed. This was the one I eventually installed, but I must admit I made a mess of bag collectors. I had some home-made bag collectors when I started and it was the home-made one I was referring to a while ago. By "home-made" I mean made by the tin shop or in the factory of the defendant.

*Cross-examination.*

By MR. WHITCOMB:

I filed an affidavit in this case in connection with a motion. In that I stated:

"Since 1921 and to the present day, the lead oxide powder manufactured by the Defendant, a commercial compound used in the—and commercially used in the manufacture of storage battery plates—has been continuously analyzed and carefully tested for its chemical and physical properties, and I have recently examined the record of these tests and analyses which are on file in the Defendant's office, and these records show, and I know it to be a fact, that the lead oxide powder manufactured by the Defendant and used in storage battery plates is the same now as it was in the beginning and has been the same throughout the entire period of manufacture. Furthermore, the process has never been changed in the manufacture of lead oxide powder for use in storage battery plates from the beginning of 1921 to the present time, and during all that time a Hardinge mill has been exclusively employed."

That's perfectly correct. That is not the powder I was talking about in the interference, it had nothing to do with it whatever. I was talking about low

oxidation products. I tried some of those, but the regular product that was being used for the manufacture of plates was what I put in that statement. It had nothing to do with this other product, this lower oxidation, in which the interference was fixed. It corresponds to my testimony in the interference. The whole testimony there was based on making the low oxidation product. I never said I used that low oxidation stuff commercially. If I did, I'd like to see it. The low oxidation is made for experiments. I went all up and down the line and very quickly adopted sixty-six or sixty-eight per cent, and that was some four or five months after I started, and we have continued that as our standard product ever since. So that I can't see the record of the Interference has anything to do with the product we have been making and using in the storage batteries.

BY THE COURT:

Q. What was the date of the interference?

A. I think it was—

MR. WHITCOMB: 1928 and 1929.

THE COURT: What was the date of the hearings?

MR. WHITCOMB: The taking of the testimony was in 1928 and the hearings went on into 1929.

THE COURT: Well, it is stated in the Interference proceedings that the black oxide was an experimental product and wasn't a commercial product?

MR. WHITCOMB: No. They go on and point out how they used it commercially.

THE COURT: All right.

I have stated that all the testimony I gave and, as reported in here, is what I gave at that time, and that testimony was entirely directed to the products which were in Shimadzu's patent, and I felt I was entitled to this. On page 41 of the Court of Appeals record I said: "'Well, what were your best results, do you remember that?' That was the question, and you answered, 'When we had sufficient air to blow the material out of the mill.''" You must take all of this testimony. You can't pick out one question.

Q. You said that, did you not?

A. Surely. Certainly, I said it.

Q. In that particular page, 53 XQ110 is: "How much air do you use now for nineteen thousand pounds of lead balls?" The answer: "About eight or nine hundred cubic feet." That's correct, isn't it?

A. Well, you will find a little bit later in there I said I didn't know how much air. That particular answer just says that. I think you will find later on in that particular testimony I said I really don't know and I didn't know how much.

Q. Doesn't any of the air go in with the balls now?

A. Just while the ball flap's open, and I don't think that's much.

Q. But some goes in?

A. No. I don't think there's enough to keep you alive—there's just a momentary flap in there.

By THE COURT:

Q. Well, now, Mr. Hall, may I—so I don't misunderstand anything—but, right in that page, it follows down there, "Have you or anyone related to you sold any of this powder?" and the answer is, "It is all consumed by the Electric Storage Battery Company,



so far as I know." Now, you are still talking about the black powder?

A. Your Honor, it was brought in there time and time again about the product that we are making, and I think Mr. Stoughton once tried to suggest we weren't talking about that product—that we were talking about the lower oxides.

Q. Now, then, on page 53, there where it says, "Have you or anyone related to you sold any of this powder?" and you said, "No, sir, it is all consumed by the Electric Storage Battery Company; so far as I know." Question, "What do you use it in?" Answer, "Use it to make plates, storage batteries, out of." Question, "You use it?" Answer, "The Electric Storage Battery Company do." Which or what powder are you talking about there?

A. That was the black powder. I made plates out of it, but they just weren't worth a whoop, and we had to throw them all out.

The witness, resuming, testified: I don't know whether during the interference I made any distinction between the higher or lower oxides in my testimony. I didn't attempt to say one was in the interference and one was not, that I recall. I thought it was perfectly understood that we were talking about the black stuff.

Q. Page 57, XQ142, "When you use the larger amount, six hundred and fifty cubic feet per minute, does that blow it all out? Answer, "It blows all the fine material out. The coarse stuff filters over just the same." Isn't that a correct statement?

A. Which question is this, now?

Q. 142, page 57.

A. Oh, all right.

Q. "When you use the larger amount, six hundred and fifty cubic feet per minute, does that blow it all out?" Answer, "It blows all the fine material

out. The coarse stuff filters over just the same." That's correct, isn't it?

A. The coarse material spills out of the Hardinge mill and, of course, any dust created by that stuff is kicking around there, when the air is blown out. Certainly, that's blown out.

The witness, resuming, testified: It is true that it blows out all the stuff that will float in the air, certainly.

Q. In this Interference record, of course, you insisted, in several instances and time and time again, you produced suboxide, did you not?

A. Well, if the Patent Office dubbed the stuff of Shimadzu's—the stuff Shimadzu made—suboxide, I thought I could use the same term. So, therefore, I called it suboxide.

Q. Well, were you pretending, then, during the Interference?

A. It wasn't pretending, any more than Shimadzu's patent was—any more than Shimadzu was pretending. He had the stuff called suboxide. I had made the same material, and I felt I was entitled to the same claims.

Q. At that time, what did you think it was?

MR. MORRIS: Are you asking from a physical standpoint or chemical?

MR. WHITCOMB: Any way the Defendant claims to have invented.

THE WITNESS: Well, are you in as much doubt about  $Pb_2O$ ? So long as it was the compound under discussion, I thought it was—I thought I was perfectly justified in using that name.

By MR. WHITCOMB:

Q. Well, didn't you go further than that? Didn't you say in the interference that you started out with the idea to get suboxide?

A. I started out with the idea of getting the low oxidation material that was made in Germany, and which I had heard about, and which, for a while, they called suboxide over there.

Q. So you knew about this material before you filed your application?

A. Not the material I am making. I didn't make the same material the Germans made.

(Discussion off the record.)

By MR. WHITCOMB:

Q. On page 64, in answer to XQ183, it says: "Olive gray powder; that is, the product we were trying to get, which we did get." You testified then that it was olive gray?

A. Which question is this, now? I didn't get that?

Q. Page 64.

A. Which question?

Q. 184.

A. Yes, we got olive gray powder.

Q. What's your answer—yes?

A. I said, yes.

Q. On page 66, referring to the various tests that you made—it wasn't just a case as to what products you are using—

A. Which test are you talking about now?

Q. From XQ194.

A. All the tests that we had made and were known at that time convinced me that the product that we were getting was a low oxidation product.

and whether the lead was combined in that shape nobody knew. I didn't profess to know.

Q. In the Interference, you were testifying, in effect, that the material was discharged from the mill by being blown out, thus making the distinction of the finer and the coarse material, on page 74, did you not?

A. Page 74. Which question?

Q. 244.

A. Of course. I was referring to the stuff that floats in the air and was going out because nobody was using his head—because it naturally discharges of its own accord.

Q. Does the air aid or detract in discharging? Does the air aid or detract in discharging the heavy material from the Hardinge mill?

A. I don't think it would amount to very much one way or the other.

When you start with an empty mill and charge it, low oxidation material comes out first, that's the product. That has a small amount of  $PbO$ , probably twenty per cent. It is a black color. Maybe it starts in very black; then in the course of an hour, it gets lighter; and in two or three, or three or four, hours, it ought to be producing stuff that is olive gray. I don't think the defendant company had a mill cleaned out and started up with a fresh charge in 1928 or subsequently thereto. There was an accident, caused by one of the men turning the motor on and it wrecked the gear. And my best recollection is that was in the early part of 1927. They have been just as you saw them, Your Honor, starting and stopping. They haven't been cleaned out. That one was on account of the wrecking of the gears. My best recollection is that it was the early part of 1927. I think it was the one to which Mr. Cooper referred. He was probably mixed up on his date a little bit on that. I think he

said it was the latter part of 1927 or 1928—I don't know which he said, but it was something of that sort. I looked it up at the time that statement was made, and I went over our records, and I could find no record of the mill being dumped from June 1, 1927, which was six years prior to the filing of the suit. That's the best evidence I can give you. They always make a record of it. I had the men go over all our records. When we started up after a Sunday's shutdown, we got the same color of lead. It comes out quite yellow first; then, maybe for a couple of drums, it darkens a little bit.

Q. Well, you have taken the position that the testimony you gave in the Interference was not correct when you gave it?

A. No.

Q. You now say the testimony you gave there was correct?

A. The nearest I could recall at the time. I gave that testimony—at the time I gave that testimony, I gave it to the best of my ability—that everything in there was correct.

(Witness excused.)

MR. MORRIS: If you Honor please, may I read of record some information which the other side have asked for—and I have just a little more, which I will have in the morning. Mr. Reinhardt was asked to supply or to tell us the percentage of the Willard's entire production that was produced by the German mill when the German mill was being operated by the Willard Company.

THE COURT: Yes.

MR. MORRIS: Well, I am advised by Mr. Reinhardt as follows: Lead dust manufactured in two

months of 1920 was equivalent to approximately one percent of litharge—and that, translated into the information we desire here, as I interpret it, is that the product of the German mill was approximately one percent of the Willard's requirements.

I have like information from the Defendant for the years 1922 to 1934, inclusive, and we have at the hotel—at the hotel, I think there is some information—the hotel, I think, has some information that was supposed to be in at noon about '16 and '18, which I will give your Honor in the morning.

This is the amount or the percentage of the product produced by the Electric Storage Battery Company, of their entire product or material used. The percentages were as follows:

In 1922, we produced 5% of our requirements.

In 1923, 9.6—that's the percentage—of our requirements.

1924, 25.2 per cent of our requirements.

1925, 41.3 per cent of our requirements.

1926, 51.2—or 5—percent of our requirements.

1927, 56 per cent.

1928, 59 per cent.

1929, 63 per cent.

1930, 65.4 per cent.

1931, 69 per cent.

1932, '33 and '34, 75 per cent, for each year, of our requirements.

I hope to be able to give your Honor in the morning like information with respect to the years 1916 to 1918, inclusive.

(Discussion off the record.)

MR. MORRIS: So far as I know, I am about ready to rest, but I should like, if your Honor please, if you will grant me the indulgence, to check it up with my data tonight.

THE COURT: Oh, yes.

(Discussion off the record.)

THE COURT: I wouldn't hold you to it, if you found you had forgotten, anyhow.

MR. MORRIS: Thank you, very much, but I think I can do it with five minutes, in the morning, anyhow.

THE COURT: Yes.

(Discussion off the Record.)

MR. MORRIS: May I offer in evidence the Plaintiffs' answer to Defendant's interrogatories, as the Defendant's Exhibit 184.

THE COURT: Yes.

(Said answer to interrogatories was then marked as the Defendant's Exhibit No. 184.)

(Court adjourned to ten-thirty A. M., Thursday, October 10, 1935.)

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## DEFENDANT'S EVIDENCE (Continued).

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MR. MORRIS: May it please Your Honor, the percentage of the product of the defendant in this case made by the German mill, so-called, in 1916 and '18 was slightly less than one per cent. of the entire requirements of the defendant.



It is stipulated and agreed, Mr. Betts, by and between the respective parties that payments were made to the defendant in this case by the New York Railways Company for the batteries made of the lead dust made in the German mill in Philadelphia under and in pursuance to and in conformity with the terms of the contract with New York Railways in that regard.

MR. WHITCOMB: That is all right.

MR. MORRIS: I offer in evidence as Defendant's Exhibit number 185 Dr. Ullmann's notes re heat of reaction for the gray oxide. It is just the same as yesterday, I think, with certain minor changes and certain recitals clipped out. I have the recitals that he has clipped out if you want to see them.

(Notes of Dr. Ullmann relating to heat of reaction were marked Defendant's Exhibit number 185.)

I offer in evidence as Defendant's Exhibit 186 the German patent to Shimadzu number 487,700, a photostat copy of it, and the translation. The translation, of course, is always subject to correction.

MR. WHITCOMB: Is that in the answer, in the pleadings?

MR. MORRIS: Oh, no, no, but you put in the file wrapper and contended that you got a broad German patent, and we do not so read it. We are putting it in to let the Court determine.

MR. WHITCOMB: You have the whole file.

MR. MORRIS: You don't have the patent in, though.

MR. WHITCOMB: All right.

MR. MORRIS: The translation is 18-A.

(German patent in Genzo Shimadzu number 487,700 was marked Defendant's Exhibit number 186.

Translation of German patent to Genzo Shimadzu number 487,700 was marked Defendant's Exhibit number 186-A.)

MR. MORRIS: Mr. Whitcomb: Can it be stipulated that the apparent specific gravity of the Berzelius oxide is between one and three?

MR. WHITCOMB: We don't know that, of course.

MR. MORRIS: All right, may I wait until after rebuttal to put that in, if Your Honor please? If Dr. Clark doesn't know it—

MR. WHITCOMB: We don't know that, I guess.

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EDWARD CLOCKER was called as an expert witness on behalf of defendant and, having been first duly sworn, testified as follows:

*Direct-examination:*

By MR. MORRIS:

I am a graduate of the Lehigh University. I have been doing special work in the Chemistry Department of Lehigh this year. I have ascertained what the apparent gravity of the Berzelius oxide is. I found it to be 1.215.

*Cross-examination.*

By MR. WHITCOMB:

I made the oxide under a vacuum at 280 degrees

Centigrade. I placed lead oxalate in a 125 C. C. Erlenmeyer flask, heated it to 280 degrees Centigrade under a vacuum, and left it there for twenty-four hours, flooded it with nitrogen, and removed a sample in an atmosphere of nitrogen.

MR. MORRIS: I offer in evidence as Defendant's Exhibit 187 a translation of the Berzelius article that has been referred to from time to time in the testimony.

(Translation of Berzelius. (1) Lehrbuch der Chemie, fifth edition, Vol. 2, pp. 611, 612, 1844, was marked Defendant's Exhibit number 187.)

MR. MORRIS: Can it be stipulated, Mr. Whitcomb, that the Toronto samples were taken, that the Toronto samples were taken by Dr. Wilson and that the samples that have been referred to, the Toronto samples that have been referred to in the case so far and that have borne his initials were taken by Dr. Wilson impartially for the respective parties?

MR. WHITCOMB: Absolutely, sure.

MR. MORRIS: What, may I inquire, is the situation with respect to the numerous log sheets of the defendant that were brought to this court on Thursday of last week by Dr. Wilson, having been selected by him at random from all the records of that character of the defendant company?

MR. SCHAFER: The log sheets will be returned. We have them at the hotel and they are now ready to be returned.

MR. MORRIS: I see.

MR. WHITCOMB: We didn't know they were here for some few days.

MR. MORRIS: Then it is stipulated and agreed by and between the respective parties, or not, that the log sheets selected by Dr. Wilson have been inspected by the plaintiffs and will be returned at the conclusion of the case by plaintiffs to defendant?

MR. SCHAFFER: It is so stipulated.

MR. WHITCOMB: Well, we want to look them over—

MR. MORRIS: Then I don't know whether it is so stipulated or not. I don't want a stipulation if they don't want it, but somebody said, "It is so stipulated", and then Mr. Whitcomb—

THE COURT: Yes, is it or isn't it?

MR. WHITCOMB: You mean without introduction, is that what you are driving at?

MR. MORRIS: No.

THE COURT: No, all he wants to get in the record—

MR. WHITCOMB: Absolutely.

THE COURT: —is that you have the sheets and have examined them.

MR. WHITCOMB: Oh, certainly. I thought he meant to preclude our putting any in.

MR. MORRIS: If you put any in you will put in a fair cross section of them, not any irregular days. I don't know what they contain.

Then, lastly, I am not just sure, notwithstanding I think Your Honor was good enough to advise me at one time earlier in the case, whether I should make a request at this time that

all the exhibits that have been offered by defendant and numbered should be formally accepted.

THE COURT: Well, it doesn't matter, I will receive them all in evidence—

MR. SCHAFER: The same request is made on behalf of the plaintiffs.

THE COURT: —subject to any objections that may have been made to any particular ones.

MR. MORRIS: Oh, yes.

THE COURT: As to those which were not objected to, they will be received in evidence, and the others will be ruled on at the time the case is disposed of.

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CLARENCE A. HALL, a witness on behalf of defendant was recalled.

*Cross-examination (Continued).*

By MR. WHITCOMB:

I filed my application for patent about March 29, 1924. As a part of my duties I follow the chemical abstracts relating to processes relating to our business. I did observe the chemical abstracts appearing in the chemical journals of March 10, 1924 that referred to certain Japanese patents by the plaintiff in suit here, Genzo Shimadzu. That has all been gone over in the interference, and I testified at that time that I did not see that particular copy until after that patent was filed. I so testified. I testify the same thing now. I have some thirty and forty magazines to go over and they sometimes accumulate, and I did

not see that until after my patent application had been signed, which was the 28th of March, and the patent records shows the 29th, when it was received in Washington.

MR. MORRIS: Well, if Your Honor please, I do not think objections are much use in a patent case or any other case, but we are not trying the Hall issue here, and I just do not see the pertinency of this inquiry.

THE COURT: Well, I will have to note the objection and take it subject to it, because I do not myself see—

MR. WHITCOMB: Sure.

THE COURT: —what it is leading up to.

MR. WHITCOMB: Well, we would just like to have of record that these were published at that day.

MR. MORRIS: I will stipulate it if you will produce the article.

MR. WHITCOMB: Well, here they are, several of them. These different titles are all written down here. All appeared before he filed, one, two, three—

MR. MORRIS: Well, I never heard of but one. I will have to get Mr. Hall to look them over. If he will look them over and Mr. Hall says it is all right I will so stipulate.

THE WITNESS: Judge Morris, we have the chemical abstract for that particular number in our files and we can have that taken out of that. That thing was all hashed over in Washington, they tried to infer that I saw that.

MR. MORRIS: If you will talk to somebody about it I will stipulate whatever publications were made before.

MR. WHITCOMB: Well, particularly I ask with respect to the reference to the Japanese patents 42,562, 42,563, 42,564, 44,223, 42,048, 44,222, 43,562, 40,704, 37,620, 41,728, 41,953, in the chemical abstracts appearing in the chemical journals, some in February 10, 1924 and others in March 10th, 1924.

THE WITNESS: I don't know that there was anything in February 10th, I thought it was March 10th. There were three or four patents,—

MR. WHITCOMB: Yes.

THE WITNESS: —but I wouldn't say that your dates are correct without getting the journal, because you may be mistaken on that.

By MR. WHITCOMB:

Q. Well, will you do so and check it up?

A. Be very glad to. I have got the journal there which we can check up.

Q. The February 10th, as well as the March?

A. We haven't any February 10th here. Have you got a February 10th? My recollection of the first reference to any Japanese patents was March 10th.

MR. MORRIS: You better work that out. I withdraw my suggestion of stipulation.

MR. WHITCOMB: Well, subject to correction we will produce the February 10, 1924 journal and see if some of these I have listed do not appear in there.



THE WITNESS: Well, you will have to. I don't know how I will remember all those numbers. I suppose I can get them from the record.

In my patent application I referred to the use of 150 cu. feet of air a minute. As an example of one way of running the thing, and the patent covers anything from low to high, and, therefore, you would use a small amount of air, large amount of air, and that is a particular example. If you take the whole definition of the patent I think you will find that particular example is perfectly all right for that particular product. According to Dr. Wilson's report, we use at least 300 cu. feet of air now. That is right. The regular product has been manufactured with 300 cu. feet or 350, it is a slight variation one to the other, to my best recollection for about eight or nine years, or probably ten years. I don't remember the figures as to the rated capacity of the number three Monogram fan that we employ and the speed at which we run it, but I know it gives a large amount of air if you just take it as free air. But if you back it up against bag pressure and various things like that, why, you don't get that amount of flow. The amount of air that that fan delivers at the rated capacity has absolutely nothing to do with the amount of air going through the mill. I imagine it must have been that capacity in order to draw a certain amount through the mill, counting the resistance. You have to have a certain amount of pull there to get air through the mill, the amount of air you want. The air going through the mill is between three hundred and three hundred and fifty cubic feet. I haven't the slightest idea what proportion of the capacity of the fan the resistance of our system gives to its capacity. We kept on getting lar-

ger fans until we could get the amount of air through the mill that we wanted.

Q. And you desired to increase the amount of air, is that right?

A. Three hundred cubic feet is what we wanted for this particular product. At one time, at least, during the time of the filing of the application we were using one hundred and fifty cubic feet, we were getting a small amount of product out. We doubled the air intake, and doubled the product too. The rate of discharge and the amounts of charge in the mill was nineteen thousand pounds I think, as described in the patent, and that is what we have been using ever since. We have had a speed of fourteen revolutions almost from the start. The rate at which I feed the balls is according to the material as it comes out, making, of course, allowance for the increase in oxidation. If you get four hundred pounds out, why, slightly less than four hundred pounds to always maintain your load of nineteen thousand pounds. At the date of the application or thereabouts we were feeding about 480. You are just taking that one example in there and trying to pin everything down on that. That is just a typical example of what you can run. I ran some at that example in 1924. Since then we now feed enough to get out eleven hundred pounds of material in the same mill. The R. P. M. is the same. The size of the drum is the same. We changed the size of the ball. It was a larger ball than we originally used but the load of nineteen thousand pounds is the same.

We experimented with lower oxides. We went on as I explained yesterday until we got an oxide that was most suitable for our plates, and that was 66 to 68 per cent and we made it then and have been making it ever since for our factory work. That was

way back in 1921. The testimony given in the interference in 1928 was given then in reference to that low product and not to this other product. We tried to use the other product commercially but it was never successful. I don't think Willard used the low powder. That was a guess. I stated I knew of the German mill before I filed my application. I worked at the Storage Battery Company in 1906 for about a year and a half, I suppose, that is all. Then I went back on July 5, 1920. I had all the data on the German mill and so testified, everything that had been done up to that time was handed to me. The powder from the German mill is a different product from that I made under my mill.

MR. MORRIS: Well, I am wondering, if Your Honor please, if the patents of Mr. Hall do not speak for themselves in that regard. It deals with a specific type of product, it deals with the range in percentages, and those patents are in evidence, but I only call that to Your Honor's attention.

MR. WHITCOMB: But you must remember those very claims were adopted by this man in his Interference, and he claimed to have made this same product.

MR. MORRIS: No, as I understand the Interference—

MR. WHITCOMB: Some of these product claims were—

MR. MORRIS: Precisely, but may I have Plaintiffs' Exhibits 16 and 17, Miss Johnson, please—17 and 18? All this that I see is of an amorphous lead oxide powder of olive-gray color, and so on.

MR. WHITCOMB: You are reading the detailed patent that Hall finally got after he lost the Interference to Shimadzu.

MR. MORRIS: Sure, I am.

MR. WHITCOMB: But the very claims in issue—

MR. MORRIS: In the Interference?

MR. WHITCOMB: —in the Interference are in suit here.

MR. MORRIS: Oh, then I misunderstood you. I thought you were talking about the claims in the Interference; sure, you are right in that, but still I do not see the pertinency of this inquiry.

THE COURT: Well, I know, but I am not sufficiently familiar with the Interference to rule on it now, and I will have to take it subject to the objection.

(The witness resuming testified):

The patent application that I filed which had the claims in it was the patent that was finally allowed to me. Those claims were never changed. It was the additional patent claims in the Interference that were the things that were dropped out. That describes a product that is gray in color and does not burn, if you put water on it it makes mud, and it has different properties than the Tudor product. Does that answer what you—

It is different. I am describing the gray oxide. I say it has a gray color, it does not burn in the air when you put a match to it, if you put water on it it makes mud. This is the gray oxide that we now make. You are asking me to describe the product. I am

giving you my description. Comparing the product that you claim was the result of the apparatus and process of my patent application with the product of the German mill, the product of the German mill was something that would burn, and when you dropped water on it it would continue to oxidize. It had different properties from the properties of gray oxide, physical properties. I don't imagine there is any chemical difference but there is a mechanical difference in the way those chemicals are mixed. Because of my association with the various people that have worked on the product of the German mill, now, I am giving you the information which they have told to me. I understand that the very fine material in both products is just about the same. But when you are talking about screen products there may be some variation from one to the other. I don't state they are substantially the same. I don't think you realize the difference in the product. I have told you the difference, but you don't seem to understand that. The mechanical differences make a very different physical product to use. The differences resolve themselves into the difference in the way those things are mixed together, not necessarily the proportions of large and small. One may have the oxide on the outside and the other may have lead on the outside, and you get a dark looking powder in one place that burns; in the other you get a product that won't burn on account of the oxide which is on the surface. You see, Judge, the process in which the gray oxide is made in the Hardinge Mill, it is mauled through this amount of partially oxidized stuff, as it goes out the end; and in the Tudor Mill the stuff drops out and it doesn't go through a mass of oxide, so that our stuff is coated with  $PbO$ , where the other material that drops out of the mill has got a coating probably of

very fine particles of lead. I suppose you could make a mixture of large and small particles in which the large particles will be outside of the small particles. I don't know but you can have just as small particles of the lead oxide as you can of the lead. They are both small particles, really both covered with particles, we will assume, of the same size. If one was coated with small particles of  $PbO$  and the other was coated with small particles of  $Pb$ , they would look very different, they would act very different to the air and water. They would look very different if you took black and white particles and then the other is different in that you are liable to have the stuff to ignite in your drums and catch fire, and all that kind of trouble in the factory, which is a hazard, whereas this material, there is no hazard in handling the stuff. Where I say "this material", I mean the gray oxide.

I said that my patent application gave one example. By varying that example I can get what Exide produces today by that same disclosure. If I may have the patent I would like to read the one sentence in there which I think may help you. We can make the gray oxide of the present production strictly in accordance with the disclosure of my patent by selecting one of the methods or one of the rates disclosed there certainly. Yes, absolutely. It is within the range of this disclosure. It says here: "It is not the intention to limit the invention in respect to the size of the lumps or balls of metallic lead or to the exact size and speed of the mill, or to the quantity of the air, or to the temperature of the reaction, as they may be varied in accordance with practical requirements. Control of these factors, however, is the spirit of this invention, whereby any product once



established may be kept substantially uniform in quality."

*Re-direct-examination.*

By MR. MORRIS:

I told you yesterday that what I was referring to in Washington was my black oxide and what I was manufacturing and had been manufacturing for years and years in my process at E. S. B., is the gray oxide. The amount of PbO in the low, that is, the black material, is less than the amount of PbO in the gray oxide.

A. Yes.

Q. Now, Mr. Whitcomb asked you a moment ago if there was any chemical difference between those two products, and I understood you to tell him so. Is that right?

A. The amount of PbO in the low, that is, the black material is less than the amount of PbO in the gray oxide.

Q. So that, then, there is a chemical difference to that extent?

THE COURT: Judge, I may have misunderstood him, but I thought he said they were the same chemically, the German product and the black oxide. Isn't that so?

MR. WHITCOMB: We also.

By THE COURT:

Q. Weren't you saying that the German product did not differ chemically from the black oxide, or did you say that? If not, why, don't leave me under the impression.

A. It is pretty hard to recall just what I said,



but if I may clear the situation, all these products contain red  $\text{PbO}$  and metallic lead. Now, it is a difference in mechanical mixture for those products whether you have the German product or whether you have gray oxide. "Distribution" is better. Different distribution of those. If you have the  $\text{Pb}$  in the inside and the  $\text{PbO}$  on the outside of one, and in the other you have the  $\text{PbO}$  on the inside, we find under the microscope that there is a difference and the various men that have worked on it say that is the difference. The whole mass of material that comes out of the Hardinge mill from—the very nature of the Hardinge mill is a lot of material at the end, fine material, which is not quite fine enough, it hasn't worked out. Now, all the stuff goes through that, and if you take something and roll it around in flour, take some black particles and roll them around in flour, won't that flour stick to the outside? Now, that is what happens to our product. We got a variation from small amount of, almost colloidal material up to stuff that goes through 100 mash. There we have a different problem, but your problem where they are all the same size, I think probably you are correct, but where you have such a wide variation of sizes, I think that as the microscope shows, that our product of gray oxide is surrounded with  $\text{PbO}$ , and that is the reason it is gray, where as the Toronto product which was the German product, is black, because it has got a thin coating of lead on the outside. If you have a theoretical mixture, all the sizes were alike, I would agree with you. But if you have such a tremendous variation in mass I think that that would not hold.

THE COURT: Well, I guess we all agree on the thing.

MR. WHITCOMB: Yes, sure.

MR. MORRIS: Well, the testimony is that that contains, the Toronto product contains substantially the same percentage of PbO and the same percentage of lead as the one is our gray oxide,—

THE COURT: Yes.

MR. MORRIS: —now, so that it is obvious from a glance that there is a difference of physical distribution.

THE COURT: Sure.

MR. MORRIS: And the testimony also of Dr. Ewing is that the particles, the finer particles are substantially of the same degree of fineness in those two, that there is some difference in the extent of size of the larger particles. I wonder, without carrying that theory further, whether there might not be something in Mr. Hall's suggestion that in the gray oxide the particles are not removed from the mill immediately upon being formed but they are rumbled in a bed of oxide, as Your Honor saw it in this little whirligig we had here,—

THE COURT: Yes.

MR. MORRIS: —that the sand worked out towards the end, but there is always sand being rumbled down underneath the bails, although it is being fed toward the outlet by the action of the mill, so that the object of my question was merely to call Mr. Hall's attention to the fact that in one of his answers he had not specifically stated that between—that there was no chemical difference between his black oxide, as I understood it, and the gray oxide, although he had testified—

THE COURT: All right.

MR. MORRIS: —numerous times that there was a difference in the percentages.

(The witness resuming testified):

We got a larger output with larger balls, and the amount of air that we used was substantially the same, in other words, we used up more of the oxygen in the air that was going through. We used more, but we did not have to change our volume because we had an overplus in the smaller balls. You see, the smaller balls are all so tight together that the larger ball has more surface openings in between.

Q. Mr. Hall, learned counsel for the plaintiff has been making inquiries about your application in 1924. I now inquire how long the Hall mill had been running prior to the filing of your application.

A. We started in '21 to run the Hall mill.

Q. Very well, now, then, I would like to put this question, but I don't believe I ought to. If the other side objects or Your Honor objects I won't press it. I would like to ask you, Mr. Hall—don't answer this—did you find any more instructions, any instructions at all in patents 149, or 150, or 151, or 152, or 479, or 020 as to the volume or amount of air that is to be put through a Shimadzu mill.

A. I have read all those—

MR. WHITCOMB: Of course, we didn't ask him about the Shimadzu patents.

MR. MORRIS: Of course not, but they asked him about the disclosure of March 10th, and would have Your Honor draw the inference Mr. Hall copied it. There isn't a word in the patents about it.

THE COURT: Well, I guess the main thing is that Judge Morris's question is on the record.

*Re-cross-examination.*

By MR. WHITCOMB:

We did not use hollow balls when we increased the size but that introduces a very beautiful question. Those balls start solid, and as they are worn down a hole develops inside, and it has been the subject of much discussion why the thing gets a hole inside of it, so finally the hole inside gets larger and the outside gets smaller until you get such a thin shell and the ball just collapses. That ball starts solid, and, Your Honor, with the smaller balls we never could tell, it got down to about pea size and then we never could find anything, and it wasn't until we went to the larger balls that we commenced cutting them open and finding this hole.

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DEFENDANT RESTS.

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PLAINTIFFS' EVIDENCE IN REBUTTAL.

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GEORGE L. CLARK, a witness on behalf of plaintiffs was recalled.

*Direct-examination (Continued).*

By MR. WHITCOMB:

Q. Now, Dr. Clark, you have heard testimony of defendant's in connection with the various testimony you gave and exhibits and data you submitted.

THE COURT: You mean the defendant's witnesses.

MR. WHITCOMB: Defendant's witnesses, pardon me, please.

By MR. WHITCOMB:

Q. I understand you have a list of items you desire to take up, and will you please go ahead and state on the record what you have to say in connection with the various items mentioned by defendant's witnesses?

A. What I shall have to say will be very brief. I think it is entirely unnecessary to repeat my own testimony or theories.

First of all, of course, the X-ray, the discrepancy in the X-ray results. I have the highest respect for Professor Davey and Professor Anderson and their work, of that there isn't any question at all, so that the matter simply devolves into attempting to reach a common ground or to analyzing wherein differences might lie.

In the technique, first of all, there seemed to be only two fundamental differences in technique. One was the type of and the method of holding the specimen. Both Professor Davey and Professor Anderson used sealed capillary tubes, while we used a wedge of the powder itself.

Another difference, of course, is that in the samples in issue we have utilized always, of course, vacuum in our cameras, vacuum camera. We used in the early part of the investigation, as I have already stated, a General Electric apparatus, and abandoned it because I felt that the films were not good enough to prove anything one way or the other. Now, what effect the vacuum camera has, of course, is difficult to

say. We found on recent investigations, especially on complex materials of various kinds, that vacuum in the camera makes a very profound difference in bringing out certain interferences which would be very difficult in the case if the beam were scattered by air. Of course, that is true the longer the wave length, we would have been unable in recent studies of living nerves, and things of that kind, to have obtained the information which we did, we would not have been able to bring out except by eliminating the air completely from the camera and the use of the vacuum camera.

The second point of possible difference, of course, has to do with the specimens.

By THE COURT:

Q. Pardon me, but you said there was a difference, in the way the object was presented to the camera, but you did not comment on it. Is there any—

A. Yes, well, I did try to before. It seemed very desirable to get rid of any containing walls of any kind of a foreign substance, like glass or anything of that type, and what was done, the question has been raised, I might describe a little bit better, is a little cradle with a sort of a peaked end—

Q. Well, I was not particularly interested in that. You simply pointed out that there was a difference, and I was wondering whether you felt that one was better than the other.

A. Yes, well, I feel, of course, that if we can eliminate any foreign—the effects due to anything foreign whatever in the path of the X-ray beam that we should have a more accurate picture of the particular specimen. That may or may not have this effect.



Q. All right.

A. Again, it is fair to say that I could not prove anything one way or the other by the early technique.

Now, it has been suggested that those specimens which seemed to give different results might be different, in other words, that my specimens might contain additional substance, carbonate, or something of that kind. Of course, there are always human limitations, I presume, in a thing like this, but in all of these cases where—especially of these Dr. Wilson's samples, the utmost precaution has been used. The exposures were taken in vacuum, as already described, and every precaution was observed so that they would not, the additional substance could not be formed. I simply make the suggestion, therefore, that there is an alternative way of looking at it other than that mine might have contained an additional substance. That, of course, is simply that Dr. Anderson's and Dr. Davey's might have lost something.

In the third place, let us take up the lines themselves. They are weak, broad, diffuse, and, as already indicated, somewhat variable in composition, and it has been suggested that some of them has submitted, that is, when the average was calculated, some of them or some of the lines could be made to fit lead carbonate, and lead oxalate, and yellow  $\text{PbO}$ , and red  $\text{PbO}$ , and, of course, would fit an approach, at least, to a cuprite type of structure, since the maximum deviation of two of the lines is two per cent.

Now, I would not necessarily limit the possibilities if we just select a few lines to these particular substances. We might have, we could match some lines with sodium chloride, maybe, or with urea, or with almost anything of that sort. In a case like this the best judgment has to be used, not in selecting fractions or fragments of patterns, but to make the



whole picture fit as well as possible. These patterns, these weak, broad, variable lines, have been obtained from mill oxides, from layers on balls, from oxalate experiments, and when I say oxalate experiments, I include those of which there can be not the slightest question of complete decomposition, that is, heated at temperatures for twenty to twenty-four hours, and things of that sort. We have one hundred and twenty-five or more experiments of that kind, as previously described.

But let us for the moment take up these suggestions that have been made. I might—I might add, also, to the previous one, of course, that we find these same strong lines in the fractionated sample, and, at least in one instance, in an experiment made of exposing metallic lead to oxygen, where the lead was very carefully melted and dropped into oxygen-free water to reduce the grain size, and the surface very carefully removed, and a fine powder produced.

Let us consider these compounds, lead carbonate, for example. Some of the lines by the usual powder method in the series of curves shown by Dr. Davey unquestionably approximately fit here and there, there isn't any doubt about that. On the other hand, the centrifuge sample which showed these strong lines, the strong lines which corresponded to the average of these other very weak lines, does not effervesce or liberate  $\text{CO}_2$  when treated with acid. It blackens on heating at vacuum, as already described, and when heated in air it becomes yellow  $\text{PbO}$ , which can be pretty well identified by sight. The lead carbonate, if the additional third substance found under the microscope is lead carbonate there certainly is no evidence of that at all. Lead carbonate is biaxial. It has a refractive index widely different from that

which is measured on these little semi-transparent or transparent clumps. As stated yesterday, its value was 2.553 plus or minus .002.

By MR. WHITCOMB:

Q. Pardon me, Dr. Clark, when you refer to, when you are differentiating from the carbonates and you point out these things that happened is your testimony that if it were—that they did not happen, rather, whereas if it were carbonate that would happen? Will you make that very clear, please, about the blackening?

A. Well, what I simply mean is this, that with such tests as we made on the centrifuge sample, producing these strong lines, when the centrifuge sample was tested there was no effervescence or evolution of  $\text{CO}_2$  with dilute acid.

Q. Would there have been if there was a carbonate?

A. If there had been lead carbonate there would have been, yes.

A well-known test of the mineral cerussite, for example, is the evolution of  $\text{CO}_2$  by dilute acid. The compound blackens on heating in vacuum; that is, the centrifuged had not actually blackened on heating in vacuum, which, of course, lead carbonate would not do. In air the centrifuged sample changed to yellow  $\text{PbO}$ , of course, which carbonate might do, and finally, if we associate the third substance microscopically observed with the additional substance which is presenting itself in the X-ray patterns, the microscopic examination both in polarized light and by refractive index certainly indicates it is not lead carbonate.

Turning to lead oxalate—I may say, of course, in connection with the preceding, too, we have stand-

ard patterns of lead carbonate, and have always been anxiously on the lookout for any matches of that kind.

Q. And you found none of this substance?

A. There is no—there is no accurate match of this pattern in its entirety with a standard pattern for pure lead carbonate, although it is perfectly true that rough checks or matches can be made with some of the lines, as already indicated.

Lead oxalate has been mentioned. We have many films with oxalate lines on them from our oxalate experiments, many of them, some made at 305 degrees, 300 degrees, and even higher temperatures for short periods of time, and checked against the pattern for pure lead oxide.

MR. MORRIS: I can't quite hear you, Dr. Clark, I am sorry.

THE WITNESS: I am sorry: I say we have many films, we have made many films of oxalate samples which show undoubtedly oxalate lines, that is, at 305 degrees and 300 degrees, lower temperatures, and so on, and, as a matter of fact, we probably have one or two films at 310. That is exactly the reason why I said it was so extremely sensitive.

On the other hand, of course, we have films, as indicated a while ago, for products at higher temperatures for varying periods of time. I simply suggested that in film C-119, which was made at 310 degrees for two hours, there seemed to be there a maximum intensity of lines which checked with this, with the average of these, from these other determinations.

Oxalate, of course, is not produced in the mill. I don't think that anybody could believe that, or on the balls. I don't believe that I have made it clear,

our experiment with the lead balls as received from Dr. Wilson—

THE COURT: I can't quite hear you.

THE WITNESS: I say I don't believe I made it clear just how we experimented with the lead balls from the mill. The whole ball was used as a sample; mounted in a camera with nitrogen, and a beam of X-rays very carefully adjusted right across the top of the ball, just so it would skate right across, or be tangential to a surface, and the corresponding patterns were made, the patterns in evidence were made in that way. Then a little, very carefully, with a razor blade, just the tiniest bit of the outside layer was removed, and another photograph made with the same ball in the same position, and so on, down through, through various layers.

The tabulation, of course, shows that in the inner layers these weak, diffuse, broad lines appear in somewhat greater intensity than from the outer surface of the ball, and, of course, under those considerations I feel that we could not pin the pattern upon lead oxalate.

Our chemical analyses are only very approximate. Of course, lead oxalate would have only seventy per cent of lead in it, and, of course, if our centrifuge sample were completely lead oxalate, the analysis, which was in the neighborhood of ninety-five per cent, of course, would almost certainly eliminate the possibility of it being a large per cent of lead oxalate.

We turn to yellow  $\text{PbO}$ . Admittedly, again, it is an orthorhombic substance. These lines, some of them, possibly many of them, can be and are roughly matched to some of the lines which we have observed.

The yellow  $\text{PbO}$  we have worked a great deal with in connection with other problems, and we think we know quite a bit about yellow  $\text{PbO}$ , and especially its transition to red  $\text{PbO}$ . In a mill sample the grinding process is absolutely opposed to the existence of yellow  $\text{PbO}$ . Yellow  $\text{PbO}$  is stable as a high temperature modification, is converted easily by grinding at room temperature into the red tetragonal form. That can be demonstrated easily by anyone, and I do not think there is any evidence whatsoever that there is yellow  $\text{PbO}$  in the oxalate experiments at the—under the ordinary conditions. Of course, the microscopic examination again indicated—indicated not the presence of a biaxial crystal like lead oxalate or yellow  $\text{PbO}$ .

Red  $\text{PbO}$  has been suggested; perfectly willing, perfectly admitted that a few of these red  $\text{PbO}$  lines, three or four of them, almost exactly coincide with the patterns under consideration. We obtained such—such excellent patterns for red  $\text{PbO}$ , and the lines are so perfectly definite, and we can measure them so accurately, just as Dr. Davey and Professor Anderson have done, that, of course, there is no complete correspondence between the patterns at all, except with respect to an approximate superposition which we have recognized, of course, from the very beginning, and in the centrifuge sample, for example, of course, the most essential lines of red  $\text{PbO}$  are completely missing. I do not think the centrifuge sample could possibly be that. We have fractions scraped off of the walls of the super-centrifuge, which show the well-defined red  $\text{PbO}$  structure. Of that there isn't any doubt at all.

Then if we take these lines from another point of view, we have seen they vary somewhat from one substance to another, they are broad and diffuse,

somewhat difficult to measure. We have used the microphotometer, and I feel in spite of some objections the microphotometer is a very useful subsidiary auxiliary to help us in them. When we take this average as shown the other day, two of the lines show a maximum of two per cent deviation from the theoretical match for a cuprite-like type of structure, and this, as we have indicated, these patterns are very similar, of differing intensity, of course, for mill oxides, where they were very, very weak, centrifuged samples, lead oxalate, lead and oxygen, they have never been found in many specimens which we have examined, we have never found them in any reduction, any reduction process at all. Now,—

By THE COURT:

Q. What is a reduction process?

A. Where we reduce an oxide, a higher oxide, to a lower one, by hydrogen or hydrazine, or something of that sort.

THE COURT: They want to relieve the stenographer. I suppose we might take five minutes.

MR. WHITCOMB: If you don't mind.

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(Recess at 11.45 o'clock A. M.)

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GEORGE L. CLARK, recalled.

*Direct-examination (Continued)*

By THE COURT:

Q. Now, will you resume, Doctor? Before you do you might tell me one thing that I didn't grasp and



that is as to just how the slicing of the lead balls you referred to eliminated the possibility of the presence of oxalate in the photographing of the successive slices?

—A. Yes. That's simply this, if oxalate were present it would mean, of course, lead oxalate would be formed in the Exide mill, and there has never been any evidence of a complete or definitely identifiable pattern of any product made in these mills that corresponds to lead oxalate.

Q. You took a solid lead ball—

A. Yes.

Q. —and you took a razor blade and sliced it?

A. Yes.

Q. And as they got deeper there was a difference of some kind. You said that eliminated the possibility of lead oxalate being there. I don't know why but I didn't quite understand that.

A. I was simply trying to explain the technique in some more detail. The outer surface, when examined, when it produces such a pattern, gives a pattern corresponding to, very nearly, a high percent of  $PbO$  tetragonal, a little lead, and only the very faintest evidences of additional substances. As we go down in under this outer layer and in more or less intimate contact with the lead, these additional, that is, these extra lines become stronger, as if something were more or less in greater concentration.

Q. I can see that, how it strengthens your conclusion that  $Pb_2O$  exists, but I don't know how it eliminates the oxalate.

A. Well, that, by itself, would not necessarily eliminate the oxalate, except that we assume that lead oxalate is not made in an Exide mill.

Q. All right. What that experiment really does



is to fortify your conclusion that the thing you get is  $\text{Pb}_2\text{O}$  and, of course, it follows, as that conclusion becomes stronger and the possibility that it is something else becomes weaker. I suppose that's what you had in mind, all right. I thought there was some well-known chemical reason why. I understand it now, go ahead.

A. We were just at the place of considering very briefly, these lines having eliminated the correspondence with lead carbonate, lead oxalate, yellow  $\text{PbO}$ , and red  $\text{PbO}$ , and taking this substance with its variable lines, where we find by calculation which, of course, Dr. Davey made the other day, two of these lines—we just take an average of these variable lines, showing that two of them have a maximum deviation in the whole spectrum of about two percent of a theoretical match with a face-centered type of lattice or cuprite type of lattice.

This I have, by long thought and consideration of this particular pattern, I felt to be consistent with the principles of the addition of oxygen to lead, the principles of a varying solid solution of lead—the point being that if the evidence of this particular material, being no experimental evidence, measurable experimental evidence, of metallic lead with a tiny bit of oxygen in it. You couldn't measure that, but evidence of the fact, some evidence is present here, showing, even with variations, the approach or the attempt to confirm an intermediate type of structure represented by the distorted cube or something of that kind.

Now, this undoubtedly, although the pattern is different—I mean, is similar in showing a rough correspondence to the face-centered lattice, I think, better than the other or than any other possible substance previously mentioned. It must differ from

silver oxide and cuprous oxide, that is, the particular compound, because it is so unstable and these other two substances are so stable, and also in the fact when we calculate or make a theoretical calculation on the basis of lead and oxygen for this thing which is indicated here, that the lead atoms would have to have a size very nearly the same as they possess in the metal itself.


And, of course, there we enter a twilight zone about which there is some, not very much definite information about the actual valence forces that are concerned, but certainly they must be considerably weaker than they are in silver oxide, that is, where the electron, completely to the oxygen and copper, loses the electron and the result is that the silver and the copper ions have appreciably different sizes, than correspond to the sizes of those of silver and copper in the metals.

However, we have analogous cases, as already mentioned. We have palladium and hydrogen—that's a system which has been studied more than anything else, I suppose, along this line. Palladium takes up hydrogen continuously and passes through a state which is called  $PbH$ , and yet represents a continuous take-up of hydrogen by the palladium lattice, and  $PbH$  represents one stage, one particular stage, along that line.

Then, of course, I might mention also the fact of the carbon in iron martinsite.

It is, therefore, hardly a fair criticism, possibly, that this sort of chemistry is irrational and not very reputable. The new field of the study of distorted structures and solid solutions, where we are dealing with compounds or with combinations that are not in the simple ratios of whole numbers, as we have so

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long come to expect from the laws of John Dalton. All this is very new and requires very much work. We are interesting ourselves as much as we can, and from every experimental form of view, as to what does happen in distortion when we do have these broader line cases, and in such a system as that, as this, it is hardly necessary, it seems to me, to assign a definite valence value of one to lead, in the sense that lead would lose one of its outer electrons, to something else and have existing a single positive.

There are lots of things that are happening that chemists haven't thought could be possible, and would be in, designated in years gone by as not very reputable chemistry. I have in mind the experiments at Western Reserve, which I think have been definitely proved independently by others—the rare gases of the atmosphere form compounds of helium, argon, and so forth. That's been one of the chemists' great biblical statements—that these rare gases should not and must not combine with anything because their outer valences show they are saturated. There is no quarrel here at all with the great history of chemistry, not in any sense at all. There's no attempt in any of this thought to overthrow the well-established principles of chemistry. I wouldn't for a moment sit here or anywhere else and, knowingly and willingly, do such a thing as that, but I do say that chemistry is progressing, it is moving, it is changing. Some of our concepts of long ago, aged concepts, are changing.

Another example, of course, is the fact that a nucleus of atoms can be burst all to pieces—one atom changed to another. That would have been rank heresy a few years ago.

And so, in my thought, in opposing this as an interpretation of the investigations which we have

made—they are not complete by means, by any means—it has been with no thought of doing something irrational but we have to take into question a newer field which has been opened only by newer, precise methods of investigation and measurement, dealing with these distortions and with the peculiar conditions of adsorption and absorption and solid solutions and things of that kind. Single chemical compounds may sometimes do curious things, things not previously suspected, and it is on this basis that the interpretation of a series of lower oxides of lead has been submitted.

I have nothing to present, no comparable measurements to present against, or to compare with many of those that have been presented. I only wish I did have, but I feel it has not been demonstrated that chemical analysis could or could not, or could actually and definitely disprove this. As far as I can see, there has been no proof that chemical analysis could do that. I have not been able to do it although maybe somebody can. Density measurements, amalgamation experiments, heats of reaction, and things of that sort, have been presented. No doubt, I haven't any doubt that if we had made measurements that many very similar results would have been obtained to compare with those already submitted.

And, again, I feel that taking, that taking, these possibilities, these various types of measurements, I didn't feel that the substance containing so small an amount of a variable composition, the density measurement, I didn't feel it could mean very much. The amalgamation experiments presented by Dr. Ullmann were certainly very beautiful experiments, and the Lehigh laboratory is to be congratulated on working out a technique of that kind, I think. I think, as an



addition to our chemical literature, that that will be much appreciated. But there, again, it would be impossible, on the basis of that amalgamation experiment, to tell whether variable substances were amalgamated or were not amalgamated, or what did happen to it. And the same thing would apply to heats of reaction. There is no question but what the calorimetric measurements can be made with extreme accuracy. The principles established by Theodore W. Richards and many others constitute a splendid page in the history of physical chemistry. But again, here again, has come along some very interesting new information which was presented here yesterday. It was mentioned here yesterday as having to do with the possibilities that, under certain conditions of preparation, certain oxides, not all of them were investigated, by any means—there's only a few so far—could have very, very different energy values. In other words, zinc oxide can be prepared, which is an extremely active catalyst, in the preparation of methyl, and so on. Yet the same zinc oxide can be prepared and treated a little bit differently, at a higher temperature, and it has no catalytic activity at all. The fields of chemistry and industry mystify people very much indeed.

Calorimetric measurements were made of heats of reaction, and we found marked differences in the active and inactive—more or less, inactive—depending upon the method of preparation, that the activity of the particular substance—it is chemically active, it has chemical activity, it has catalytic activity—and its catalytic activity was tied up intimately in with the higher basis of potential energy contained, potential energy content of some kind. The only possible consideration that has been reached so far by Fricke and

his co-workers is, under certain conditions, zinc oxide, beryllium oxide, lead oxide, and  $PbO$ —only very partial experiments, I guess, have been made on those—might actually exist, in which the planes were enough distorted so that the atoms were while the balance of the energy of zinc was normal or perfect.

Now, where that enters into a problem of this kind, it is very hard to say. Only ferric oxide can be made five thousand calories higher than another—no other preparation at a higher temperature—and whether that enters into this situation yet, we don't know yet. It simply raises the question of whether the heat of reaction, by itself, would it be adequate, clearly distinct—a system, very largely, of beautiful crystalline lead, beautiful crystalline red tetragonal  $PbO$ . There isn't any quarrel about that at all.

Now, of course, we might comment at a great deal of length but it isn't necessary to do that upon the peculiar history of the last hundred years.

MR. MORRIS: I wonder if that would help us, if your Honor please?

THE COURT: I think I will let the witness proceed.

MR. MORRIS: All right.

THE WITNESS: I don't mean in any sense to enter into that situation, because it has been just simply an interesting history already presented with all sorts of papers, all sorts of experiments that have been made dealing with the oxide of lead, this lower oxide of lead. And, it just seems a curious phenomena—to me, at least—that, to this day, you cannot, I don't think anyone can, adequately explain, either one way or another, some of the results that have been obtained by men who have or have claim claimed the



existence of an absolutely definite compound,  $Pb_2O$ , assuming the valence of lead equals one.

There's the paper, a recent paper, by Pascal and Minne, Sorbonne, in Paris, using an independent method of magnetic susceptibility. He very carefully prepared a compound from lead oxalate, and simply finds that the magnetic susceptibility of that particular material simply cannot be made to match the magnetic susceptibility of any synthetic mixtures of Pb and PbO. It can't be made to match any materials.

MR. MORRIS: If your Honor please, the witness is going into an additional reason not given in his opening, this magnetic susceptibility, and we will ask leave to produce some witnesses on that.

THE WITNESS: Well, I will be glad to withdraw that.

THE COURT: I think, possibly, as long as he didn't make the experiments and is only speaking of, generally, what is known as general literature, it might just as well be. I suppose it is all available to me, if I wanted to read it.

THE WITNESS: I will be very glad to withdraw that.

THE COURT: All right. I would be glad if you would—let me ask you this:

By THE COURT:

Q. I would be glad if you would tell me a little more definitely what you think is wrong with Dr. Davey's and Dr. Anderson's experiments because, while they are all—I realize that all of you have enormous respect for one another, I get that idea—but I also get the idea that you think there must be

something wrong with his results because he didn't reach the results that you did. Now, did he have—let me ask you, Dr. Davey, as I understand it, simply did not find a number of lines which you found and he found a few lines—correct me if I am wrong—he found a few lines which corresponded with a flow of your critical lines. Was that his testimony?

A. Well, I think that—

Q. As you understood it?

A. Dr. Davey did not, if I remember right, in any of his experiments, did not find additional lines. Professor Anderson, in some oxalate experiments, found additional lines which he said were due to lead oxalate.

Q. Well, Dr. Davey had a suggestion that they might be carbonate?

A. Yes.

Q. Those lines that he was talking about were a few of the lines which you relied upon to show  $Pb_2O$ , weren't they?

A. Yes. That is, he took these data of mine and fitted them; not what he obtained.

Q. Did he—

A. No, he fitted them in what he obtained.

Q. Did he obtain them?

A. Yes.

Q. All right. He didn't obtain any of your  $Pb_2O$  lines, then?

A. I don't think he did.

Q. Why don't you think he did?

A. Depending upon—that's just his testimony. As I say, it is impossible to tell what the source of discrepancy is. It may reside, first, either in the technique. He used, of course, throughout, the General Electric type of apparatus.

Q. —and save reading them?

A. Sure.

Q. Then we can read them afterwards, since we are working against time.

MR. WHITCOMB: Of course, we want them read into the record.

MR. MORRIS: I thought we would put them in the same as we did the heat of reaction. All right.

THE COURT: What are they directed to?

MR. WHITCOMB: Detailed differences in answer to the question I just asked on the action of the Tudor mill as he understands it compared with the action—

MR. MORRIS: I have no objection, either way. I thought that they could be put in the same as the heat of reaction.

THE COURT: You mean as part of his testimony?

MR. MORRIS: I mean as part of his testimony.

THE COURT: Yes, all right.

MR. WHITCOMB: It is two or three pages.

THE COURT: Well, just insert it at this point as though he had testified to it.

MR. MORRIS: Perfectly all right.

MR. WHITCOMB: Of course, we wanted the benefit of your Honor's hearing it, but I don't see that that—

THE COURT: Well, I am going to read it.

MR. WHITCOMB: Read it anyway, all right. Counsel for plaintiff offers in evidence—

THE COURT: Just at that point insert those notes, just as though he testified to it.

MR. WHITCOMB: —the five sheets produced by the witness and asks the Clerk to mark the same Plaintiffs' Exhibit number 64.

(Papers entitled Testimony of Dr. Clark re Tudor Mill were marked Plaintiffs' Exhibit number 64.)

THE COURT: Well, you have this really in the form of testimony.

MR. WHITCOMB: Yes.

THE COURT: So it goes right into the record at this point.

MR. WHITCOMB: Yes.

THE COURT: All right, go ahead.

MR. WHITCOMB: It was practically exactly in the form of question and answer.

(A copy of Plaintiff's Exhibit number 64 follows:

“August 26, 1935.

Dr. Clark, Messrs.  
Yamaoka, Wood and  
Schaffer.

#### TESTIMONY of Dr. Clark re Tudor Mill

Q. Are you familiar with the so-called Tudor mill as operated in Toronto?

A. I was not present to make an inspection or to see the mill in operation, but I have studied the drawings and talked with those persons whom I understand were present during the operation of the mill.

already indicated, in such an inert atmosphere the balls just tend to polish each other; that is, there is a mutual effect one upon the other, and there is no—no product formed such that it can be discharged from a ball mill, or something of that kind.

Q. So that your position is that what might happen by scratching on a piece of paper would not be indicative of what went on in the mill?

A. Yes.

Q. And that, therefore, your theory of the molecular formation of the lead particles is the correct one, is that right?

A. Yes.

Q. By the way, what is the color of the Prest-O-Lite oxide samples or samples that you have examined made according to the Shimadzu process?

MR. MORRIS: Well, I don't know whether it is made according to the Shimadzu process or what departures were made from that, so I would rather not have your conclusion on that.

By MR. WHITCOMB:

Q. Well, state whether or not they are according to your understanding of the patents in suit.

A. According to my understanding the Prest-O-Lite product is made by the Shimadzu process in the Shimadzu mill, and it has a greenish-gray color, the present mill samples as I have received them.

Q. And how about the product of the USL mills, can you say the same thing or not about them?

A. Yes, same.

Q. Greenish-gray, do you mean by that to convey the idea of a dark gray or a light gray?

A. Well, they are not a dark, dark gray at all; it is a—it is more of a sort of a grayish, brownish, olive

color. It is very hard to describe the intermediate shade or hue.

Q. Were you familiar with the so-called Tudor mill that was operated in Toronto, its construction?

A. I have not seen the mill and I didn't see the test made at Toronto, but I have seen the drawings of the Tudor mill and I have talked with those who were present at that test.

Q. And that Plaintiff's Exhibit 43 represents your idea of how the action takes place as you indicated on your direct-examination?

(Plaintiff's' Exhibit 43 was shown to the witness.)

A. Yes.

By MR. WHITCOMB:

Q. You notice certain additions have been put on the drawing since then, and will you bear those in mind and state whether or not you find differences between the Tudor mill as you understand it and the operation, and the Shimadzu mill of the patents in suit and the process of the Shimadzu patents?

A. I can in no sense qualify as an expert in aerodynamics or aero-statics or anything of that sort. When this question was asked me some time ago, just purely from a more or less chemical point of view, I attempted to formulate an opinion as well as I could. With your Honor's permission I would like to, for the sake of saving time and for accurate statement, I would like to refer to these notes which I have simply prepared.

By MR. MORRIS:

Q. Can you submit the notes as they are,—

A. Yes.

MR. MORRIS: What lattice work structures?

MR. WHITCOMB: Of any kinds.

MR. MORRIS: Oh.

THE COURT: Well, the only thing is, I don't know what the question means, exactly.

MR. WHITCOMB: As compared—show how many of those by any possibility, if any, form in this cuprite type.

THE COURT: All right.

MR. WHITCOMB: That is the thought.

THE WITNESSES: Well, I assume you refer to the existence, naturally or synthetically in the history of chemistry of all different crystalline substances. It would be impossible to form an accurate estimate of that. I suppose Beilstein, for example, lists several hundred thousand organic compounds alone. Carbon compounds and crystalline compounds would certainly run into the hundreds of thousands which are known. Not all of them by any means, of course, have been investigated.

By THE COURT:

Q. Does anybody know what proportion of those have the cuprite structure?

A. Well, the percentage must be extremely minute, that is, from the X-ray point of view and so far as we know,  $\text{Cu}_2\text{O}$  and  $\text{Ag}_2\text{O}$  have been definitely assigned to that structure, and the  $\text{Pb}_2\text{O}$  was assigned to that following the work of Ferrari, of course. So far as I know those are the only—only representative of—well-known, at any rate—of this type.



By MR. WHITCOMB:

Q. Well, this morning did you point out why in your opinion the substances you have been investigating and reported as a suboxide of lead could not have been the other substances such as the zinc blend, sphalerite, the sodium chloride, or sodium iodide, or cuprous oxide, and if not, will you do so?

A. Well, it is, of course, only reasonable that in all of the specimens under investigation lead is the element concerned. Certainly there cannot be any of these other things out of a mill, you could not have copper salts or zinc salts or things of that sort when you start with pure lead oxalate, and, of course, the presence of lead can be qualitatively ascertained very easily in these compounds by dissolving and precipitating the lead by some identifying test, either lead chromate or lead sulphate, or you could use the charcoal bead test, make a button of metallic lead, and so on, all the well-known tests for lead, so that I do not think there could possibly be any misunderstanding but that we were dealing with lead compounds.

Q. So that in your opinion eliminates all those four, is that right?

A. Well, it eliminates calcium fluoride and all, yes.

Q. What have you to say about the color of these samples as a distinguishing characteristic or not?

A. Well, I think a great deal of dependence has been put upon color when it is, of course, justified and well-known that the color of any mixture is determined by the fineness of grinding—

MR. WHITCOMB: Pardon me, will you read his answer?

(The answer was repeated by the Reporter.)

to find any evidence of which or any constituents that we might happen to think about which may or may not mean anything.

(Discussion off the record.)

THE COURT: All right. We will take that up after lunch, then. We will resume at 1.30.

(Recess, 12.30 to 1.30 P. M.)

AFTER RECESS.

Present: Counsel as before noted.

GEORGE L. CLARK, recalled.

*Direct-examination* (Continued).

By MR. WHITCOMB:

Q. Dr. Clark, will you state on the record our position, your position, with respect to the idea of any reversibility, that is, describe it as compared with the dissociation, so as to make that clear on the record.

MR. MORRIS: I assume that is not a departure from our understanding of yesterday.

MR. WHITCOMB: No, I assume not.

MR. MORRIS: Then I wonder if it needs any explanation.

THE COURT: Do you think it does? What is your idea?

MR. WHITCOMB: Well, the point was that, of course, we did not retract in any way from the position that plaintiffs took for the formation of  $\text{Pb}_2\text{O}$  from the lead with the oxygen, and then the dissociation of the  $\text{Pb}_2\text{O}$ . That would not be construed as a reversal.

THE COURT: Well, all right, if he wants to distinguish between dissociation—

MR. MORRIS: Then I have no objection.

THE COURT: That is what he wants to do?

MR. WHITCOMB: Yes.

THE COURT: And the reversibility.

THE WITNESS: Then I simply want—I am sorry that there was some misunderstanding about that, all that I meant was simply this, if we did consider the possibility of a reversible reaction,  $\text{Pb}_2\text{O}$  equals  $\text{Pb}$  plus  $\text{PbO}$ , yet would that reaction go completely, or very nearly completely, at any rate, from left to right, that is from the  $\text{Pb}_2\text{O}$  over into lead plus  $\text{PbO}$ , because of the continuous removal of lead, either by oxidation or by growing into inactive grains, and I just want to make that clear, that the dissociation is what is mean in this case.

By MR. WHITCOMB:

Q. And what happens in connection with dissociation?

A. Well, suboxide of lead dissociates into lead and tetragonal  $\text{PbO}$ .

Q. Did you point out how many possible crystalline substances there are that might be subject to an investigation in producing these different lattice work structure?

By MR. WHITCOMB:

Q. Is or is not, I mean, I want to know, I thought you lowered your voice—

A. Yes, I say in the past by many people, is what I mean to say, by many people a great deal of dependence has been put upon color to identify a product, but we know perfectly well that color is not a dependable criterion of the constitution of materials, because the color depends upon the fineness of division, subdivision.

That was, of course, well illustrated yesterday where we had the difference between the very palest yellow and the very deep orange-red for  $PbO$ , and it is simply that unless we know very, very more facts about any given material, about any given mixture, especially that the denomination or the distinction or characterization of that mixture chemically is not justified upon the basis of just color.

Q. Do I understand you have a definite reason why you can eliminate the lead oxalate from the results you found from the Exide mill samples? If so, will you state that?

A. Well, the synthesis of lead oxalate must be, of course, a very complicated process, presupposing the presence of carbon in considerable amounts, the synthesis of oxalic acid by some process, and I think we can simply eliminate any possibility of that—of the synthesis of lead oxalate in the Exide mill, because I do not think anyone would admit there is any considerable amount of—any more carbon than the minute traces, small amounts, which might be naturally present in the air, and certainly there would not be any for any such synthesis.

Q. In connection with particle size please state what your position is after hearing defendant's witnesses testify with respect to the formation of the

small lead particles by the molecular theory, as you described in your direct-examination.

MR. MORRIS: Is there any departure?

MR. WHITCOMB: I think not, no; no departure.

MR. MORRIS: Well, then, let him just say so.

By MR. WHITCOMB:

Q. State whether or not there is any departure from your position—

A. No.

Q. —in any way. And what have you to say about defendant's witnesses' testimony about particle size in that connection, if anything?

A. Well, the example was shown of rubbing a piece of lead on a piece of paper, which was then examined microscopically and presented as evidence that lead could be produced by an abrasive process. Of course, anyone can draw, obviously, can draw a line of —with a soft piece of lead can draw a line on a piece of paper. Paper is—does have certain abrasive properties. If we may suppose, however, that that paper now is just covered over with lines, coated over with lines completely, so that it is just a solid mass of lines, I would expect that it would be exceedingly difficult, if not impossible, within measurable limits to produce a further measurable abrasion of lead on lead.

In a mill of this kind, of course, what we are really having is one ball writing a mark on another ball, and vice versa, back and forth and back and forth, and we know that in an inert atmosphere, I think both sides have agreed to that, that in an inert atmosphere practically no measurable discharged product is produced. I have seen inside of a mill, and find that there is a considerable—just like a lead mirror covering the inside coating of the mill, and, of course, as we have

MR. WHITCOMB: I think that is one of the points the Court would like to know about. Will you please—

By THE COURT:

Q. You all used the General Electric first?

A. Yes.

MR. WHITCOMB: And discarded it.

By THE COURT:

Q. Were you able to get results with it?

A. The films were not clear enough, in my mind, to be able to distinguish one way or the other because of the fogging, the very long time required, and that was the reason.

Q. From your General Electric apparatus results, you would have made the same report that Dr. Davey made?

A. No, I don't think I would, that is, just simply the results were definitely in doubt; that is, you couldn't be sure whether they were faint lines there or not. That's the point.

Q. He was sure they were not?

A. Yes.

Q. All right. Now, can you tell us a little more about what you think the difference in technique—results, I mean—how you got your improved results from your other apparatus?

A. Well, I have tried to indicate—there's that, of course, the continual experimental effort towards getting just as clear and sharp film as we could. I might say that I have just simply let the films themselves, let the films speak for themselves.

By MR. WHITCOMB:

Q. But, Dr. Clark, I don't think the Court appre-

ciates these points nothing like a chemist does, and that's what the Court is inquiring about. I don't think there's—there is no use being modest. Tell what you think about them.

A. I simply feel—I wasn't satisfied with our results or with the technique at all. We had eliminated completely any containing walls of capillary tubes, and things of that kind, so we could use the specimen itself and could use a camera at vacuum, with vacuum, to eliminate any possibility of scattering due to the air. Of course, that also actually improves—I mean, it somewhat decreases the time required—it's not very much, but to some extent. Thus, when we had made that combination, we have produced these films and which I feel, with a very considerable degree of satisfaction, with accuracy, of course, as already has been attested to by Professor Davey.

Whether that's it or not, no one could say, I suppose, unless Professor Davey came to my laboratory and used the same apparatus, to the best of his ability and with such precaution as he thought best.

The other alternative, of course, is that the samples, as studied, actually differed somewhat, that is, either, as Dr. Davey has maintained or suggested, that his might have had something missing which was present in mine. Now, that is all. I think that is all I can say.

By THE COURT:

Q. It seems to me it would be a great deal, especially, to get an additional substance—it would be a great deal easier to get an additional substance in, or one out? Am I wrong?

A. Well, you have, of course, you have to avoid the possibility of contamination and impurity. On the



other hand, if you have present some unstable substance, why, of course, it can disappear. That's the thought.

Q. What precautions are necessary to prevent the disappearance of an unstable substance such as  $\text{Pb}_2\text{O}$ ?

A. Well, the principal thing, of course, is its sensitivity, sensitiveness to elevated temperatures, to the elevated temperatures; under any consideration, and then the ease with which it oxidizes, particularly when a small amount of moisture is present. That's the reason I had these samples put over  $\text{P}_2\text{O}_5$ .

Q. What's that?

A. Phosphorous and oxide.

THE COURT: Well, I guess that's all.

By MR. WHITCOMB:

Q. What about the length of the exposure of Dr. Davey's films as compared with yours?

A. Yes. He testified to many hours, I think twenty-four or forty-eight, or whatever it was, I don't just quite remember. There was the effort here to make comparisons out over as short a time as possible. We would expose some films longer but I present, for comparative purposes, the film exposed just long enough—an hour, that's on the average—to give a good pattern without any undue exposure.

By THE COURT:

Q. Do you think too long an exposure might result in some inaccuracies in the result?

A. Well, there is always that possible. Of course, the X-ray tube heats up considerably and in a closed system, especially, where sets are pushed up close to the cylinder which holds the X-ray tube. Of course, there's the possibility of some temperature rise and, especially, over a long period of time.

By MR. WHITCOMB:

Q. Is it your opinion there that that might have influenced the material in the tube in Dr. Davey's experiment and, possibly, changed the suboxide or some form of suboxide, so that he didn't get in his total results?

A. That's entirely possible because I know that from our own experiences with the same mill under various conditions. We have gotten films perfectly, and perfectly free from these additional lines, perfectly plain and about which there isn't any doubt at all.

By THE COURT:

Q. How many experiments did you make, that is, how many X-ray analyses did you make?

A. Well, in the course of this whole investigation, of course, as I have said before, we have made nearly, I suppose, five hundred films, dealing with all phases of the subject.

Q. How many analyses of the gray oxide did you make?

A. Why, we made the analyses with the official samples submitted and signed by Dr. Wilson.

Q. But how many times did you "shoot" that?

A. Well, there's been—of course, each one of those—each specimen was divided, really, into three parts and screened and so forth. We made a film of each one of those, and then several incidental films have been made with material exposed to air, of course, and material after being centrifuged, and after standing for some period of time. We made some in the month of September, this year, after the samples had stood all this time—and, oh, the principal proposition is to produce a good film of the samples as they came. These other things were simply to enable us

will therefore be condition by the formation of such water films and therefore the mechanism of the Tudor process should be sensitively conditioned by such factors as humidity. On the other hand if air is introduced as a forced and directed stream and by virtue of its viscous slip along solid gas innerfaces such directed currents will have a well known sweeping action which dislodges absorbed films of moisture or other protective liquid or gaseous materials. Because of this action therefore the effect of changes in water vapor concentration in the atmospheric air becomes negligible in the operation of the Shimadzu process and under all conditions the normal rapid reaction of absorbing oxygen with the metallic lead takes place with little or no hindrance and thus has an essential constant rate. This freedom from the deleterious effects of relatively minute variables is therefore a distinguishing feature of the Shimadzu process. Whereas, in the Tudor process the essential oxidation process is at the whim of the elements of nature and atmospheric conditions and the reaction zone is subjected to the rules of fugacity in which the tendency is for the air pressure to push out of the drum. Therefore there is a tendency to have an insufficient and variable supply of oxygen at all times thereby subjecting it to deleterious effects from atmospheric conditions and changes. The principle of the Shimadzu mill is exactly the opposite in that instead of the fugacity the air is directed and forced into the drum in such quantities as to overcome such hazards and thus to insure a smooth, continuous and uniform operation at all times.

Q. Is it possible to operate the Tudor mill in a satisfactory condition as the Shimadzu.

A. No matter what the combination of variables as regards temperature, size of lead pieces, rate of rotation, dimensions of the drum or other mechanical features, the Tudor mill without the essential condition present in the Shimadzu process of a directed and forced current of air cannot and does not give a satisfactory performance as measured by the production of a commercial product.")

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By MR. WHITCOMB:

Q. Then subsequent to your discussion of those questions about the action of the air I would like to ask you what in your opinion would be the results if you attempted to take the mill as it is there, as Defendants had it in 1915 and in 1916, according to their testimony, and in 1917, and yet in 1920 used the type of mill with the increased force draft, with the air going into the inside drum, and state what would occur if you attempted to force the draft into the mill as shown on this Exhibit 43. What would be encountered in your opinion?

A. Well, I think that would constitute a new invention.

Q. Upon what do you base that answer?

A. Of course, that is— part of my answer, part will depend or goes back to the analysis which I have made in these notes, but the—

Q. That is, this Exhibit 64?

A. Yes.

Q. That we just introduced.

A. But the production change, the change from a process producing, as I understand it, only a limited amount of product, very limited amount of product, to

one in which there is certainly a commercial utility and value.

Q. By the way, in the Prest-O-Lite Mill or in the U. S. L. Mill do you know about what the production per hour is, from your examinations of those mills from time to time?

A. I have seen those mills and I have seen them in the course of an hour fill a drum of four hundred pounds and another one half full or so, or maybe a little over; averaged ~~somewhere~~ between six and seven hundred pounds per hour.

Q. And how does the size of the drum compare with the size of the drum as illustrated in the alleged Tudor prior use, as shown in Plaintiffs' Exhibit 43? The Prest-O-Lite is a little larger drum, is it?

A. It is longer, as I understand it,—

Q. Do you know how much?

A. —but the same diameter.

Q. Do you know how long?

A. Five feet long, and five feet in diameter.

Q. Then will you proceed with your answer to the other question, before I interrupted you?

A. Will you read the question, please?

Q. As to why you thought it would constitute a patentable invention.

A. Well, simply because a production of fifty or sixty pounds an hour, which goes up to seven hundred or six hundred, between six and seven hundred pounds an hour, certainly represents the difference between a not very satisfactory, certainly, commercial process and one that is, and, in other words, an increase in production of ten-fold by any process added to this set-up which would increase that production ten-fold would seem to me to constitute a very valuable additional feature, which is an invention.

Q. To put it another way, Dr. Clark, assume the

operation as in the alleged Tudor prior use shown in Plaintiffs' Exhibit 43, and assume everything just as it was there according to the testimony, and you put on a fan and immediately substantially increased the passage of air, leaving other things equal, what would that show, what would that result in, according to your understanding?

A. Well, other things being equal it would result in—as is known—in an increase of production, very greatly increased production of product.

Q. Well, but wouldn't the air have a cooling effect on the same load at the same speed?

A. An increased blast of air in a combination like this, other things being equal, with the same load and the same speed, would, of course, tend to produce a cooling effect.

Q. Then what about the passage of the material? The air takes the material in one direction in the Tudor construction, and in that the discharge is in the opposite direction, is that right?

A. Yes.

Q. If you increased the draft of air in that arrangement, what would happen?

A. Fine particles of material, of course, would be carried in the air as a carrier up through the stack.

Q. Why would an engineer have to reorganize the structure, then, under this increased production. Will you please explain?

A. Why; he would lose his—lose his product, of course, under the construction like this, and, of course, the regulation would have to be made of charge, amount of air, rate of rotation, and method of discharge, so that an optimum, or, at least, a very highly satisfactory condition of oxidation is made possible and the product removed and collected.

Q. And before the change had been made to this great increase in production and the engineer at-



Q. Do you find differences between the defendant's Tudor mill and the Shimadzu process?

A. Yes.

Q. Point out briefly what those differences are.

A. In answering this question I will summarize first the essential features of the Shimadzu process as I understand them from a study of the subject. In a horizontally revolving cylinder a charge of metallic lead pieces is subjected to the oxidizing effect of a blast or forced current of atmospheric air; by the combined chemical action of oxidation and the abrading action of oxidation and the abrading action of the pieces of lead rubbing against one another a fine powder is produced by attrition which is removed from the mill through the carrying agency of the forced current of air. The product so obtained on exit from the mill is collected in suitable manner in order to obtain a satisfactory commercial yield. The Shimadzu process depends essentially upon the action of atmospheric air in excess quantity since the oxygen in the air is necessary for the reaction with metallic lead on the surfaces of the lead pieces forming the charge in the revolving drum. In order that a powder may be formed by attrition, it is essential that an oxidized layer be formed on the surfaces of these pieces this said layer being characterized by brittleness and the possibility of detachment as the pieces come into contact with each other. In this forced current of air the supply of oxygen is being continually renewed so that the concentration of oxygen absorbed on the lead surfaces is kept essentially constant and at no time during the course of operation of the mill or in any zone of the charge is there im-



poverishment of oxygen with resultant change in rates of absorption of oxygen on to the surfaces, chemical reaction with the lead and diffusion of oxygen through the outer oxidized layer into underlying layers of unreacted lead in the individual pieces. This is the first and chemically essential function of the introduction into the mill of a positive blast or continuous forced current of atmospheric air containing oxygen. This forced current of air has at least two other functions. The second is, of course, the effect which it has on the temperature, not only of the gaseous atmosphere in the mill but also the charge of the solid reacting material since all of the reactions which are proceeding in the mill have definite and marked temperature coefficients. The effect of a continuous forced current of air at constant temperature in maintaining constant temperature gradient as well as in supplying a constant supply of oxygen is an essential function. The third function is to afford a constant method of removing the powder from the interior of the mill in which the forced current of air acts simply as a carrier. The directed and forced current of air which is an essential attribute of the Shimadzu process distinguishes clearly and definitely this process from that in which the Tudor mill is involved. In the Tudor process the reactions proceed in the presence of atmospheric air at ordinary pressures and this atmospheric air is introduced into the mill merely by the normal influx through the various openings in the mill from the outside air of the room in which the mill operates. Thus, the only possibility for the replenishment of air in the interior of the mill which is being exhausted of oxygen as a result of chemical oxidation processes is

by this natural diffusion of ordinary atmospheric air from the outside. This ingress, however, will be opposed by the following tendency of the air within the drum. As a result of the oxidation and attrition process, the temperature rises not only in the solid mass but also in the air which is not being moved or changed in any way by a directed or forced current. The given volume of air in the drum by operation of the well known gas laws will therefore exert or tend to exert a higher pressure because of this elevated temperature of the gaseous molecules. The escaping tendency or fugacity of these gaseous molecules on the interior of the drum will therefore be greater than that which is possessed by the gaseous molecules in the exterior environmental air. The tendency of the gas within the drum therefore to escape outwardly into the outer environment is actually unfavorable to the ingress of a renewed supply of atmospheric air from the outer environment of the mill. This increased fugacity due to increased pressure, of course, is balanced in whole or in part by the fact that oxygen is being effectively removed through its combination with metallic lead thus lowering the partial pressure of gaseous oxygen. Therefore the only possibility of any successful replenishment of oxygen will be that the partial pressure of gaseous oxygen is sufficiently reduced so that the total outer atmospheric pressure overcomes the greater thermodynamic fugacity of the inner gas at the higher temperature. That these processes are operative and that a positively renewed and constant supply of oxygen is essential for a successful commercial production of material is adequately demonstrated by the very low yields admittedly obtained in the operation of the Tudor

mill simply because there is an insufficient supply of oxygen to enable a continuous process of oxidation and attrition to proceed. The directed and forced current of air has a further important, though little realized, function. Experimental data which have been obtained by various workers and which are in excellent agreement prove that the Shimadzu process operates successfully independently of such factors as the humidity or purity of the air utilized in the process. Selective absorption from a mixed gaseous atmosphere upon the surfaces of solid bodies is a phenomenon well established and definitely known to all chemists. Thus, in order that any oxidation process shall proceed, it is first essential that oxygen molecules shall be absorbed upon a reactive surface as an absorbed film. This physical absorption process is then followed by the chemical combination. It is at once apparent that a large supply with constant oxygen concentration or partial pressure is necessary if this first absorption process proceeds smoothly and uniformly in all parts of the mill and continuously in time. There will also be absorbed not only nitrogen molecules which are entirely chemically inactive but also other species of molecules present in the gaseous atmosphere such as water vapor in proportion to the partial pressure of those species. In a class of atmosphere such as the character of the Tudor process relative to the directed, forced and turbulent atmosphere which is an essential attribute of the Shimadzu process, absorbed films of considerable thickness may be built up and there is no provision by which water films formed by the absorption of water vapor molecules can be controlled or eliminated. The type of reaction as well as the rate

tempted to increase the draft would that tend him to go further in that direction, or would he find that he got more production by decreasing the draft? You will recall one of the witnesses stated that when they put on the stack they decreased the air inlet.

A. Well, upon the basis of my analysis where a continually replenished supply of oxygen is so desirable in any of these processes, why, that would seem to be going in just the wrong direction, that is, to close the amount of air down.

Q. And all these considerations enter into your calculations expressed as to why you thought that would be a patentable change to modify this Tudor construction to get the results and operation of the Shimadzu patent in suit, is that right?

A. Well, to the best of my ability, analyzing the correlation or the reaction between lead and air and oxygen, why, I would say yes.

Q. Some of the prior art patents refer to the use of water in the mixture. Please state what in your opinion that would—what effect that would have in mills of this type.

A. Well, in the presence of water I think we might have an altogether different series of reactions. The water would tend to condition the temperature, of course, and you have hydration of the products, formation of hydrates, and all that sort of thing, and it seems to me would simply eliminate any close comparison that could possibly be made between either process or product.

MR. WHITCOMB: Direct-examination closed.

*Cross-examination.*

By MR. MORRIS:

Q. If you have a perforated drum the Shimadzu process cannot be carried out?

A. No, it can be carried out.

Q. It can be carried out? Then what would be what you have designated as an invention over the Tudor or German mill if you used a perforated drum?

By MR. WHITCOMB:

Q. Would you like to see the other charts, the patents?

MR. MORRIS: I would just rather he would answer that, if you don't mind, Mr. Whitcomb.

MR. WHITCOMB: Well, I think he should consider the patents.

THE COURT: Well, no, but, now, he doesn't need any help in this thing; better let him handle it himself. If he wants anything he can ask for it.

THE WITNESS: Did you finish your question?

MR. MORRIS: Yes, I did, Doctor.

THE WITNESS: Oh, I beg your pardon. Will you read it?

(The question was repeated by the reporter, as follows:

"Q. Then what would be what you have designated as an invention over the Tudor or German mill if you used a perforated drum?")

MR. MORRIS: The perforated drum of Shimadzu.

THE WITNESS: Well, the invention is a forced draft of air presenting to the lead a continually replenished supply of oxygen.

By MR. MORRIS:

Q. In what quantity?

A. Well, in large excess..

Q. A large excess quantity. Can you find that set forth in any Shimadzu patent in suit?

A. Only in the words "gust" and "forced current",—

Q. Well, you can have gusts and forced currents without large excess, can't you, particularly if your mill is large enough?

A. You say you can have?

Q. Yes, can't you, you can have a gust—

A. Yes.

Q. —and you can have forced draft without any excess volume?

A. Why, yes, of course, you can always, that is, depending on a difference, a pressure differential, you can have—

Q. So that, can you put your hand on anything in any of the Shimadzu patents which tells you you must use an excess supply of air? I am speaking now of the perforated, rotatable drum. We will come to the other in a moment.

A. Well, I would have to refresh my memory whether the words "air in excess" are used there or not, is mentioned there or not. I don't remember.

Q. I don't remember, and to save time we will have to let the patents speak for themselves.

Let's make two assumptions, then, first, let us make this assumption, that there is nothing in any of these patents to show that there is any excess of air called for in any of these patents. Will you then put your finger on the invention, as you call it, which would be required in using the Shimadzu Mill, perforated mill and process, over that of the old German Tudor Mill, when that mill is used with a stack, as testified to by Mr. Kershaw, Mr. Reinhardt, Mr. Hoelzle, and possibly some others?



A. Personally, from my point of view, at least, any difference must reside in the boundary line between a more or less static volume of air heated, which gives, of course to that—to that volume of air a certain escaping tendency, as we might call it.

Q. Did you ever use a fireplace?

A. Yes.

Q. Did you ever have smoke go up the chimney?

A. Certainly.

Q. That means what to you?

A. Well, there is no question of a draft being created by a chimney.

Q. Is there any question in your mind at all that there was a draft and changing units of air volume in the Tudor Mill or German mill, whichever you want to call it, as used by the Electric Storage Battery in Philadelphia in 1916 and '18, and in Cleveland by the Willard Company in 1920?

A. Of course, the answer to that is conditioned entirely, it seems to me, upon the presence or absence of a stack.

Q. Well, I am using the stack, I am using the stack, and I am using a forty-five inch stack on this mill, which is approximately thirty inches—the German mill in Philadelphia is approximately thirty-six inches long and sixty inches in diameter, and had 1482 one-eighth inch holes, such holes being one-eighth inch in diameter—it may be 1480, so you can take both 1480 and 1482 into your calculation—and I am advised, and if you can check that, the calculation is that these fourteen hundred and some holes, eighty-odd holes, are equivalent to a stack, to a single opening approximately four and a half inches in diameter, and if you have any doubt about that we will check it.

A. Well, there can be no question, of course, about the production of convection currents in a case like that, I don't see how anybody can—



Q. Then there would be a passage of air, depending upon the draft of your stack and the heating conditions and the extent of openings and all of that, would there, Dr. Clark?

A. There will be a passage of air toward the stack, yes.

Q. Then let's come back to our former question, do you under those circumstances see any invention made by Shimadzu in his process, when we use the German mill with the stack, where the stack has a damper, where the flow may be controlled and the intake of air down the discharge chute likewise has an opening and a closing member, whereby the size of those two openings may be adjusted to suit the conditions prevailing at the time of the use of the mill?

A. Well, it seems to me the question hangs, depends entirely upon the definition or the shading of meaning that is given to currents of air, forced drafts, forced currents, and things of that kind.

Q. Well, now, you are using, you are using the words,—

A. Yes, sir.

Q. —I am only asking questions. Won't you give such meaning to them as you like, and then put your finger for me, please, on the invention which I have inquired about specifically,—

MR. SCHAFFER: If Your Honor please,—

By MR. MORRIS:

Q. —the so-called invention?

MR. SCHAFFER: —this is largely repetition of what has already been answered in the written questions and answers that have been introduced, and unfortunately they have not been read, but largely these questions—

THE COURT: Well, I know, but it is directly, it is directly apposite to the question Mr. Whitcomb asked him, absolutely directly on it. If it is repetition it was opened up by counsel for the Plaintiff.

You did start to answer one question that Judge Morris cut in half—

MR. MORRIS: I didn't realize it.

THE COURT: —with a question of his. You started to say, and I think it comes back to it now, and I wanted to just call attention to it, you started to say there was a difference between the static body of air and something, and then Judge Morris asked another question and you have not finished your answer. I was just wondering what you were going to say.

MR. MORRIS: I would be obliged for you to go back to that, because I recall now I did unintentionally interrupt you, by putting a stack on, to call to your attention it was not a static body of air.

THE COURT: You go back to that question, Mr. Rodebaugh, if you can find it.

THE WITNESS: Well, if I can just explain a little bit what I mean there, if we can think of a more or less static body of air present in a given volume, which has been heated up, that it is in contact with heated materials and heated up, then, of course, we know that in accordance with the well-known gas laws that there is a certain fugacity, let us say, of the air molecules in such a system. Of course, that is being counteracted in part or in whole by removal of oxygen, that is, the partial of pressure of oxygen decreased by com-

collecting, removing the product by the air and collecting it.

Q. Now, they are removing the product by the air that goes through, and all of the product in that way?

A. All that I have ever seen, yes.

Q. It is not a perforated mill?

A. No.

Q. It does not operate at all on the principle of the Hardinge type, where it is, the function of the mill itself is to pour that, force the finer stuff out of the discharge opening?

A. The material which comes out of the exhaust is carried by the air as a current.

Q. That is the only way the air is used as the medium or vehicle for removing of the stuff from the mill, and none is removed in any other way?

A. So far as I know, yes.

Q. All right, let's pass that. How long did it take you to make your centrifugal samples, Dr. Clark, of the gray oxide?

A. About two days of centrifuging and preparing.

Q. So that the samples of the gray oxide that you used were in the mill two days?

A. No, that was the total time required for the preparation of the samples.

Q. That was the total. Then from the time you started you were exposing your particles of lead dust, let's call it, in your centrifuge how long?

A. Each run was a minute and—minute and a half, that is, each successive run, one and half minutes.

Q. Each run was a minute and a half?

A. Yes.

Q. So during that time your material was subjected to the action of what?

A. That was the time it was—that a given volume,

a small volume, was actually in the centrifugal chamber.

Q. I am sorry, but I didn't know that you had finished your answer. Will you give me your answer again?

A. That was the time that the given volume of the dispersed material was subjected to the fifty thousand R. P. M. revolution in the, in the—

Q. In the machine?

A. —super-centrifuge.

Q. All right. All right, now, I want to follow that process with a little care, if you will, because I have not been able quite to get it. What do you call a given volume, how much?

A. Well, it is—it is something between one-half and a teacupful, is the chamber—

Q. Well, approximately the volume, the amount you could put in that paper cup—

A. Yes.

Q. —that you have in your hand?

A. Just about.

Q. That is poured into a liquid, if I understand the process; and that liquid is what?

A. That liquid is a purified hydrocarbon.

Q. Isn't there a step ahead of that? The impression I got, Dr. Clark, was that you poured or deposited the lead dust from the Dr. Wilson's samples—I am right so far, am I not?

A. Yes.

Q. —into a liquid so that you could deposit this liquid into the machine?

A. That is right.

Q. The liquid carrying within it the particles from Dr. Wilson's samples?

A. That is right.

· bination with the metallic lead, but unless there were such, unless there is just exactly such a balance it is reasonable, perfectly reasonable to assume that air will be pushed out of such a drum under any—in any temperature differential, and, as a matter of fact, overcoming the natural ingress of air through any other particular openings.

Well, now, the whole matter hinges on how much can a stack and movement of air in the environment, how much can that affect the opposing tendency of this more or less cushion type of air, warmer air, and which is obeying the gas laws, and it is just—the final result would simply depend upon a balance, that is, whether oxygen is being removed, its partial pressure decreased enough so that the total inner pressure may be overcome actually by the passage of air around outside, around through the holes or around the holes—around the drum, as aided by, of course, a stack. Now, you have a very delicate range, undoubtedly, in there.

By MR. MORRIS:

Q. Are you talking now about a difference in principle, or a difference in degree? In answering that question I would ask you to bear in mind and advise me as to whether a stack properly functioning is not in effect a suction means in its function and operation.

A. Why, I think it is, a stack properly designed, certainly.

Q. Then your answer to the other question is what that you have been speaking about, a difference in degree and not a difference in principle?

A. I don't think I should say that, because we grant a current of air around the outside shell with that stack, but what happens in the oxidation process

and actually inside of the mill will certainly depend upon this, the temperature, the operation of these gas laws, removal of oxygen, and so on.

Q. Doesn't it in the Shimadzu process?

A. Yes.

Q. All right, then, do you find any difference in principle there?

A. In the Shimadzu process, of course, a supply of—that is the supply of air, the supply of air is—whether by suction or by direct pressure, is passing right over, as I understand it, the charge in the furnace.

Q. Then with the suction of the stack present and the heating condition in the rotating, perforated drum mill of Shimadzu do you mean to tell me there would be nothing passing through those 1482 holes, and that no air would pass through the rotating drum in the old Tudor Mill, German Mill?

A. Well, air can pass through the—in the Shimadzu Mill, there isn't any question.

Q. Now,—

A. But I say whether or not air passes in this mill—

Q. That is right, that is what I am asking you.

MR. WHITCOMB: Well, let him answer, then.

MR. MORRIS: I am asking him to answer this, and that is what—

MR. WHITCOMB: I know, but you interrupted him, Judge.

MR. MORRIS: Don't let me do that.

MR. WHITCOMB: We have had that a couple times.

MR. MORRIS: What?

MR. WHITCOMB: Interruptions.

MR. MORRIS: I am sorry.

By MR. MORRIS:

Q. Proceed, will you, Dr. Clark, and don't let me interrupt you. If I break in on any answer before you are through, please tell me,—

A. That is all right.

Q. —because I may be guilty of it at any time unintentionally.

A. The picture I have is in this inside volume of air, which is under even such conditions as these likely to have more or less static properties, and I have simply tried to portray what might be easily a possibility, that the air in that drum would tend to push out.

Q. May I ask a question now?

A. Yes.

Q. All right, then I am trying to get whether you are dealing with a question of getting air into the drum for oxidation purposes or you are dealing with some relative volume of air in the drum of the German mill, perforated drum of the German mill, and the perforated drum of the Shimadzu mill. Can you help me on that?

A. Well, in this mill I am speaking of the volume of air inside that is in with the charge itself.

Q. The German mill?

A. In the German mill, yes.

Q. All right.

A. And in the Shimadzu mill I am dealing also with, of course, the volume of air inside of the drum, in which is introduced by—directly, a supply of air right into the drum, as I understand it.

Q. Yes, now, how much, how much, in the Shim



adzu mill, and how much in the German mill, relatively speaking?

A. Well, of course, we have just spoken in that connection with the Shimadzu mill, we can judge only by those terms which I have used before, that is, drafts, forced currents.

Q. All right.

A. Enough so that a product could be removed.

Q. So that a product could be removed?

A. Conveniently, yes.

Q. That is, you are getting into the Shimadzu mill a sufficient amount of air to carry out the product?

A. So that it will be—to use the air so it will be convenient to use that air to remove the product.

Q. Remove it through the perforations, or otherwise?

A. Remove it through any—through the end or another opening, I don't know as to that.

Q. Now, in a stack four to five inch stack, that was placed on the German mill in Philadelphia and Cleveland where would you find any differential in pressure from there to the receptacle for the finished product?

A. First, the air enters the bottom, supposedly, at atmospheric pressure, the top of the stack at atmospheric pressure, for the conduction of the air current as shown any differential, any pressure at constant volume would be simply between two heated—between a heated and relatively unheated zones in the mill. Obviously, the higher the temperature at constant volume the higher the pressure will be.

Q. Now, I don't quite understand that, Dr. Clark, but let's see if we can. You mean, do you or not mean to tell me that there will or will not be a differential in pressure surrounding the drum caused by the heat and the stack and no differential of pressure inside the drum, the rotatable perforated drum?

A. Well, now, I was referring to differential in pressure between the inside of the drum and any cooler passageway outside the drum.

Q. But do you mean—I don't want to stay on this longer, because time is passing,—

A. Yes.

Q. —but do I understand you to mean that those 1482 holes do not admit currents of air into the rotating, perforated drum?

A. There is a tendency—

Q. Only a tendency and not an actuality?

A. Well, I didn't finish my question—there is a tendency, certainly, unless there is a rapid removal, or, I mean an actual, factual removal of air from the inside of the drum, for that air to be tending to expand, push out, and what sort of a balance you have, that is, how much that will prevent or overbalance ingress through the holes from the outside cooler air—

Q. Then how long will it so expand?

MR. WHITCOMB: He didn't finish.

MR. MORRIS: Pardon me.

MR. WHITCOMB: He didn't finish the question.

THE COURT: He surely did not. He said how much that will counterbalance—

MR. MORRIS: I am sorry, go ahead.

THE WITNESS: —will depend upon these factors that you have been speaking of, that is, how much difference in temperature, whether there is a possibility of entrance of air in any other way, which apparently there is not, that is, to the inside of the drum, how much covered up the holes are with lead, and so on. Of course, the main point there is that a temperature differential

in a more or less quiet body of air might be easily sufficient under the conditions of operation to effectually back out any air coming in through the holes, perforated holes.

By MR. MORRIS:

Q. Under our theory how long would it take to create a vacuum in the rotating perforated drum?

A. Well, a vacuum, of course, could never be created.

Q. Why not?

A. You have nitrogen present.

Q. Oh, no, I am speaking about the operation of the German mill in Philadelphia.

A. A vacuum created inside the drum, you mean?

Q. That is right, or do the molecules of air stay in an antagonistic position in battle array forever against any incoming molecules of air from the circulating current surrounding the drum?

A. Well, of course, that is true only so long as there is enough temperature difference, and, of course, I am—it is perfectly definite, perfectly fair to say that the lowering of partial pressure of oxygen is also a matter which is assisting or helping in the battle of the incoming molecule. There is no doubt about that.

Q. So that you really do get a current through those holes into the drum, don't you? Dr. Clark?

A. You could under some conditions, yes, but not all.

Q. Well, under the conditions of operation that you have heard of the German mill you do get it, don't you?

A. Well, I don't know.

Q. All right, but if you had fans on the stack to draw the air through, or on the bottom to force it through you might, might then get some into the drum, mightn't you?

THE COURT: Yes.

MR. MORRIS: —because I can put them together later, for whatever value they have or do not have.

By MR. MORRIS:

Q. Suppose you had installed fans on the stack to increase to some extent the current of air that was drawn through the discharge outlet and passed out the stack, would there then be any difference between the German mill and the perforated drum Shimadzu mill in operation, or the method of manufacturing powder therein or thereby.

A. Well, the difference it seems to me would be this, that as I understand it, an air—that is, this fan or current of air produced by a fan in the Shimadzu mill is introduced right in, right into the drum, and of sufficient strength and quantity so that it is convenient to remove any product as a result of oxidation and abrasion, and so on. Now, I don't know what—I don't know how you could predict, I would not know how to predict what would happen in the sense of ventilation or temperature control or effect upon the inside of the drum if a fan were put in the stack. Certainly it would undoubtedly increase the current of air around the outside.

Q. Well, the instant you increase the current of air on the outside does that not have a direct effect upon the currents of air inside the mill?

A. Well, it must, it must have an effect, yes.

Q. You say what?

THE COURT: "It must have an effect."

THE WITNESS: It must have an effect.

MR. MORRIS: Very well.

By MR. MORRIS:

Q. Now, are you being exactly fair, Dr. Clark, do you think, in comparing the present-day Prest-O-Lite process and the USL process and mills in the amount of their production with the small Tudor German mill used by the defendant in Philadelphia in 1916 and 1918, and by Willard in 1920?

A. Well, I didn't know that there was any—

Q. Well,—

A. —element of unfairness. I was simply quoting what I know.

Q. Well, isn't there a difference in size in those mills?

A. In the length there certainly is.

Q. There is a difference in the potential load, isn't there, possible load?

A. Yes, in the total amount of lead added.

Q. There is a difference in the actual load of those mills?

A. As I understand it, they use four thousand pounds, or something like that.

Q. Do they air cool entirely?

A. So far as I know they do, yes.

Q. Well, do you know?

A. Well, I am only—the mill that I have seen simply rotates in an open room, yes.

Q. That is, you mean to say you don't know whether they air cool or water cool?

A. No, I don't.

Q. Then you don't know whether they are operating under even the conditions specified in the Shimadzu patents, then, do you?

A. Well, they certainly are operating with a rotating drum, Shimadzu drum, with a charge of lead in it, and are introducing forced currents of air, and are

Q. Now, so the liquid into which these particles were first deposited was the purified hydrocarbon?

A. Yes.

Q. Hydrocarbon contains what chemical elements?

A. Carbon, hydrogen.

Q. Carbon and hydrogen. Now, then, it took that paper cupful of lead dust a minute and a half to be discharged from the centrifuge?

A. That is right.

Q. And then it never went back?

A. It was repeated—of course, this was a—I don't mean to infer that we had a batch process, in a sense, under an atmosphere of nitrogen this dispersed phase was introduced into the chamber, this entrance was from the bottom, and then the super-centrifuge operated by the turbine proceeded. Now, there are two ways you could do that, you could super-centrifuge a given volume, or you can make a continuous process.

Q. Let us assume that you can do it various ways,—

A. Yes.

Q. —but won't you just tell me the way that you did it, so that we can all get away?

A. Yes.

Q. All right.

A. First, a considerable volume of this material was run through continuously from the bottom. The liquid comes out the top. That is collected. That was run through by Dr. Bradley I think possibly three or four times that way.

Then he took individual, simply took individual bits, that is, individual volumes and subjected each one of those to a minute and a half. Now, of course, on the walls of the chamber was the solid phase that was thrown out.

Q. I understand. This stuff that you have labeled

Pb<sub>2</sub>O lines on your films was analogous to the cream in the milk separator, as I understand it, cream separator?

A. Well, the finest fraction, of course, is that which does not settle, which is not thrown out by the centrifuge at all.

Q. Yes.

A. That is the skim milk, I suppose.

Q. So that there are three classifications in the centrifuge?

A. Yes.

Q. The heavy on the outside, that which approaches colloidal, I suppose, which stays on top of the medium, and then that which settles in the middle?

A. That is right.

Q. All right. Well, now, what would be the approximate length of time that you would say that this sample that you have given us in the test tube here, and enclosed in an outer test tube was in the mill altogether, I mean, the centrifuge?

A. Well, that was in the mill possibly, let's see—not more than six minutes altogether, probably.

Q. Not more than six minutes. Now, into what was it discharged when it came out of the mill?

A. It was run—the exit pipe runs into a bottle, suitable container, which, of course, was kept from oxidizing by having nitrogen flow into it, flow into it.

Q. Well, the liquid containing—the liquid which is acting as the vehicle for carrying this product in question continued to act as a vehicle until it was deposited in the bottle?

A. That is right.

Q. Then what occurred, Dr. Clark?

A. The liquid was then removed by—in vacuum at low temperature, and the deposit—

Q. Now, were all these samples immediately removed from the liquid, or not?



A. Yes.

Q. Then when Mr. Kershaw stated in 1917 that, in his Exhibit 81, dealing with the product, and dealing with the rate produced, under his subdivision (g), with the room temperature and ventilation that "Control the character of the product as far as possible by the external and internal ventilation systems, installing fans if necessary"—

MR. WHITCOMB: If Your Honor please, now, that has no place, we want to object, that is a written document, that is not what happened, they did not have it in the mill, now, that is a point of patent law, that is inadmissible, because it was not published.

THE COURT: Well, of course, in the first place, the question has not been asked as yet. I don't know what he is going to ask about it. He said when Mr. Kershaw said—

MR. MORRIS: Yes, if I may give the thought, in answer, I am going to ask if that would not meet all his objections, but may I point out this, I am not using this document as a publication.

THE COURT: Oh, I understand that. Now, just a minute, will you ask the question,—

MR. MORRIS: Yes.

THE COURT: —and then don't answer the question until I rule.

MR. MORRIS: Will you read what I did say, Mr. Rodebaugh, please?

THE COURT: As I understand it, this hasn't anything to do with patent law, this is merely a question of cross-examining this witness as to his conclusions. Go ahead, read the question.

(The question was repeated by the Reporter, as follows:

"Q. Then when Mr. Kershaw stated in 1917 that, in his Exhibit 81, dealing with the product, and dealing with the rate produced—")

MR. MORRIS: I withdraw that question and put it this way.

By MR. MORRIS:

Q. Then when Mr. Kershaw in July, 1917 in dealing with the product of the German mill and any factors which he thought and stated had a bearing upon the rate of production, stated the following: "I control the character of the product as far as possible by the external and internal ventilation systems, installing fans if necessary", was he in accord, with his knowledge as there stated, in accord with what you have been endeavoring to tell me, or telling me.

MR. WHITCOMB: Now, our objection is that that question should be framed without reference to anybody's testimony, because that relates to a written memorandum and not actual facts as to an article in existence at the date.

THE COURT: Well, I think the chances are your objection is a good one, but I do not think on the ground you have put it. Although we have stepped way over the bounds again and again and again, and I have done it myself, I still cannot grasp the idea of asking one witness whether another witness is correct. After all, you are after facts. Now, this is, of course, cross-examination.

MR. MORRIS: I don't mind changing my question,—

A. Yes.

By MR. MORRIS:

Q. Where do the rubber gloves come in, and what for?

A. There is simply a box that—in which you can manipulate anything in a—in an inert gas.

Q. What was the cradle?

A. Cradle was brass type of holder which we always use, little holder, specimen holder.

Q. And was that put into the camera?

A. That was then put into the camera and the camera immediately evacuated.

Q. And the brass cradle left in?

A. The brass cradle was holding the powder, yes.

Q. All right.

A. Of course, the brass—any brass pieces are entirely away—

Q. So that—

A. —from the portion—

Q. So that you think, Dr. Clark, as an expert that there was less possibility of some addition being made during all those steps to your sample than there was to Dr. Davey's or Dr. Anderson's sample, and where Dr. Anderson testified that he put it in, in his small tube in an inert gas, do you think with all that operation of yours there was less chance of changing than there was—and I am speaking in good faith, now, Doctor, you may think not, but I am—that there was less chance in yours of having contamination than there was in Dr. Anderson's, let us say, who used a copper target in his X-ray machine, and who used an inert gas in which to pack his—well, "pack" is not the word, but I can't think of a better one at the moment—his material under inspection, or not?

A. I haven't any question about the—I have no

doubt of the precautions which he has used, I am perfectly willing to admit that there are several steps in this, but to the best of our ability we have exercised in the preparation of that sample, because it meant so much, every precaution that was humanly possible to make. I haven't any—I am perfectly willing to admit that there are many more steps in it than there were in simply filling a mixed oxide into a glass tube under nitrogen.

Q. Each step gave an opportunity, at least, a potential opportunity, for something to happen, didn't it?

A. Well, we—it did, of course.

Q. Surely.

A. But—

Q. If I interrupted you, go on, Doctor.

By MR. WHITCOMB:

Q. But what?

A. I say we, as far as humanly possible, we tried to circumvent any such possibility.

By THE COURT:

Q. Are you definitely of the opinion that there was no contamination

A. Yes, I am. I feel that there was not enough contamination of any kind to have produced visible, measureable X-ray lines of any kind.

By MR. MORRIS:

Q. If I understand you aright, Dr. Clark, in your work sheets you had lines other than the Pb lines and the so-called  $Pb_2O$  lines, on your Exide sheet number 10, on Plaintiffs' Exhibit 21, did you not?

A. There were some additional faint lines, yes.

Q. What compound would you have if you in-

Q. Did Ferrari have any lead oxalate in his material which—from which he derived, found approximately a like lattice pattern?

A. He might very easily have had some oxalate there. Of course, we don't know.

Q. The probabilities are he had, from what he disclosed, isn't that true?

A. Yes.

THE COURT: Well, now, it is time to relay stenographers; and incidentally, Judge, don't you think we are going away beyond the limits of cross-examination?

(Discussion off the record.)

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(Recess at 3.22 o'clock P. M.)

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GEORGE L. CLARK, recalled.

*Cross-examination* (Continued):

By MR. MORRIS:

Q. There is  $\text{CO}_2$  in the atmosphere, is there not, Doctor?

A. Yes.

Q. And sometimes it is more intense in the laboratory than in the atmosphere?

A. Yes.

Q. So that sufficient contact with  $\text{CO}_2$ , sufficient contact of  $\text{CO}_2$  with powdered lead would create lead carbonate?

A. It could, yes.

Q. Dr. Clark, how many elements or compounds have a face-centered cubic type structure

THE COURT: Hasn't anybody, on either side, run any of these experiments in ordinary atmosphere?

MR. MORRIS: Not ordinary atmosphere?

THE COURT: Yes.

THE WITNESS: Yes, we have made plenty of films.

THE COURT: What?

THE WITNESS: In plain air, yes.

THE COURT: Does it show any carbonate lines?

THE WITNESS: No.

By MR. MORRIS:

Q. Is there any  $Pb_2O$  lines on those films?

A. Well, not usually, no.

MR. WHITCOMB: But, sometimes, did they?

THE WITNESS: Yes. Yes, when there was strong samples, strong samples would show some of them.

By THE COURT:

Q. But none of these samples that you ran in the air showed the carbonate lines?

A. No, if there was any carbonate there, it was in too small an amount to show.

THE COURT: All right. Did Dr. Anderson run any in the air?

DR. ANDERSON: No.

(Discussion off the record.

A. These samples were—just as soon as we had this body of liquid, about five hundred C. C., just the minute that that was finished, why, we started the vacuum.

By THE COURT:

Q. How much is five hundred C. C., in units of teacups?

A. Well, that is, let's say, about—oh, a pint, or something of that kind.

Q. Yes.

A. That would be a good idea.

Q. All right.

By MR. MORRIS:

Q. That is a pint of liquid, and the powder that is carried—

A. Well, I have under-estimated that, it is probably more nearly—probably about eight hundred C. C.

Q. All right.

By THE COURT:

Q. Nearer a quart?

A. Well, yes, a little under a quart, something like that.

Q. Yes.

By MR. MORRIS:

Q. So that the length of time that this was in the purified hydrocarbon would probably be how long?

A. It was in the hydrocarbon, let's say—first, put the solid in under the surface of the hydrocarbon, then the—about six minutes altogether in the mill, and then the vacuum distillation or vacuum evaporation, that lasted for about a half hour.

Q. All right, will you give me the total, because I might add wrong?



A. Well, let's say about—about forty minutes, I think, between forty and fifty minutes; of that order, at any rate.

Q. When it was taken—

A. It was done as rapidly as possible.

Q. And when it was taken from the test tube and put into the first liquid that operation was done under the protection of an inert gas?

A. Yes, nitrogen.

Q. Nitrogen?

A. It was introduced—

Q. What became of the nitrogen? Did you put it into the centrifuge, also?

A. Nitrogen was passed through the outside shell of the—

Q. Of the centrifuge?

A. Centrifuge, yes.

Q. And what was the inert gas which you had in the bottle into which you dumped or spilled or ran the discharge from the centrifuge?

A. Nitrogen was flowing into it all the time, so as to keep—

Q. So that—

A. —any ingress of air—

Q. So that during that operation, as I understand you, you took the sample from the test tube, you put it in nitrogen, you put it into a hydrocarbon, you put the hydrocarbon carrying the lead dust interspersed or disseminated in it into the centrifuge, you took that out and again put it in nitrogen, then you proceeded to use it, to evaporate what, the hydrocarbons?

A. Evaporate the liquid which was left, yes.

Q. By what process?

A. Vacuum.

Q. A vacuum, and then—

A. At a low temperature, about—

cluded those lines with the other lines in a single compound?

A. We have been unable to make any match at all. There were three or four, three—two, certainly, and possibly three or four of the very weak lines that have—that match or seemed to agree with those for lead sulphate, but only—you cannot make any safe conclusion from that. We felt that the explanation was possibly that there were just enough  $\text{SO}_3$  fumes or something of that kind, in the production of the mill oxide in the atmosphere to produce very minute amounts of lead sulphate, which would not appear except under such extreme fractionation condition.

Q. You could not get that from rubber gloves, could you?

A. I beg your pardon?

Q. You couldn't get the source from your rubber gloves, could you? You couldn't get those lines from contamination from your rubber gloves?

A. No, those rubber gloves had been very carefully treated with alkali, and so on.

Q. All right.

A. Of course, they were used, the materials used with rubber gloves were not more than thirty seconds, probably.

Q. Well, that doesn't have—that is not the controlling factor, necessarily, is it?

A. No.

Q. No, but I don't understand, Dr. Clark, why you cast those lines into the discard. Won't you help me on that?

A. We have not cast—we have not been able to identify the additional lines, other than it is some additional impurity, you can see it in the microscope.

Q. All right.

A. Very small amount.

Q. But what I don't understand is why you are able to tell me that some, fewer than all the, let's call them superfluous lines, did not indicate a specific compound.

A. I don't quite get the drift of your question, Judge Morris. I am sorry.

Q. Let me try it again.

A. Yes.

Q. Because there is nothing mysterious about it.

A. Yes.

Q. See if I can make it clear. You called certain of your lines  $Pb_2O$ , didn't you?

A. Suboxide, yes.

Q. Well, yes, if you prefer the newer definition for suboxide, all right, I am not quibbling on that, but you called certain of your lines suboxide, but you had more lines. Now, I don't, I don't as a layman understand why those lines did not take—those lines taken in the aggregate did not tell you that here is a compound, that on this film the diffraction pattern of a compound which gives all the lines which you found on your film. Is there any sense in that question?

A. I think I understand—

Q. All right,—

A. —what you mean.

Q. —won't you help me out?

A. Well, in the first place there was—by any combination we could make the lines did not fall together, any type of pattern.

In the second place, we were considering the lines of largest intensity.

In the third place, the interpretation was made upon the basis that there was in this product by microscopic examination a whitish, opaque substance, and another very, very—very minute in amount. The strong lines in this, in this pattern made by the frac-

tionation process are those which we find in other measurements, previous measurements. The new ones, the new lines, which are weak, have not appeared in the mixed or mill oxides simply because evidently the amount of whatever it is is far below the possibilities of registration, and that, of course, is brief—is the interpretation I have given to it.

Q. You mystify it by reason of my lack of information. I don't understand why—well, that may take too long.

Let me ask you this, you say that you had found these discarded lines nowhere else.

A. That is right.

Q. But you had found the lines which you dotted on the film somewhere else. Where had you found those lines?

A. Those, those other—those lines, of course, by far the strongest one on the film being this so-called 2.60 line, 2.61, 2.64, 5 and 6, had been found in other samples, lead balls, mill oxides, oxalates, lead and oxygen, and so on.

Q. Now, but who else had found them besides you, if anybody?

A. Nobody had found these same lines.

Q. Nobody had found the 2.60 line?

A. Well, we think—

Q. Hadn't Ferrari, that is what I am getting to, of course, as you well know,—

A. Yes.

Q. —hadn't Ferrari?

A. Ferrari had a line of 2.69.

Q. 2.69?

A. Yes.

Q. All right. Now, did you find all the Ferrari lines? I have forgotten whether you told me you had or not.

A. Two of them, I think, two of them corresponding to his we did not—

Q. Well, in approximation,—

A. Yes.

Q. —I am not trying to pin you down to it, so that the lines—

THE COURT: Well, he hadn't got in the answer yet.

MR. MORRIS: I thought he had.

THE WITNESS: Two we did not find. There was one in our pattern which he didn't have.

By MR. MORRIS:

Q. There was one in your pattern which he didn't have?

A. Yes, that is shown on that color chart, wherever it is.

Q. Then, as I understand, the situation is this, you had in your lines the Ferrari lines and two, three or four more lines, I don't know whether it is two, three or four, somewhere in that neighborhood?

A. Let me see—something of that order, yes.

Q. Approximately?

A. Yes.

Q. Now, then, you attributed to the lines that you could compare with certain approximation to Ferrari's lines and one of your extra lines—I can't finish the sentence as I started it, so I will have to withdraw it.

So you concluded—withdrawn again; so that you assigned to the material which gave those lines, less the superfluous lines, minus one, the same designation that Ferrari gave to his approximately-like lines?

A. Yes, because that pattern, the lines seemed to approximate best to a cubic—face centered cubic type of lattice.

THE COURT: Go ahead.

MR. MORRIS: Just two more questions, if you will, Dr. Clark.

By MR. MORRIS:

Q. How many compounds have the face-centered cubic type of structure?

A. Well, there's a considerable number of face-centered cubic type structures, if we take all the chemical elements, metals, and those compounds which, with a heavy and light element, which give you an essence, a pattern which looks like a face-centered pattern.

Q. Calcium chloride?

A. Calcium fluoride, zinc blende, sodium iodide, and so on. I don't know just how many there are.

Q. A dozen, perhaps?

A. Yes.

Q. Or two dozen?

A. Yes.

Q. Will you give me the best proximate, approximation that you can make?

A. Well, there at—there are at least—there are ten or twelve, I have forgotten how many, pure chemical elements that have a cubic face center.

Q. And compounds?

A. And compounds that show a face-centered type of lattice. About two dozen, I should say.

Q. Now, will you be good enough to tell me how many with a cuprite structure?

A.  $\text{Cu}_2\text{O}$  and  $\text{Ag}_2\text{O}$  and  $\text{Pb}_2\text{O}$ .

Q. Are there any others?

A. Well, of course, you can't—I mean, if you have an element, very heavy and one light, you can't, you wouldn't know whether it was cuprite or not, but those are close in structure.

Q. That is, if there is a wide spread, is there not?

A. Yes, sir.

MR. MORRIS: I thank you, Dr. Clark.

*Re-direct-examination.*

By MR. WHITCOMB:

Q. For fear it is not clear, would you mind stating here, in these centrifuge samples you believe that none of the hydrocarbons entered into the mixture and caused any erroneous conclusions to be present in your test?

A. Well, Dr. Davey made the point that an adsorbed film of these hydrocarbons might easily oxidize. Of course, our effort, and I don't know—I can't possibly see how there was any access of oxygen during any time when the hydrocarbon was present.

Q. Then, these many precautions you pointed out were just for the purpose of avoiding such a occurrence, is that right?

A. Yes.

Q. There's one other question. You don't place your whole reliance on the finding of a suboxide—

THE COURT: Before you get to that, wait a minute.

By THE COURT:

Q. If you just take your lead oxide and put it in a hydrocarbon, are the two things indifferent to each other entirely?

A. Yes, they are. Lead oxide would dissolve.

Q. They are entirely separate?

A. Yes, sir.

Q. So that the carbon in hydrocarbon will, in no possibility, enter into the lead oxide?



Q. And in making that evacuation you dissipated or removed likewise the nitrogen that had not been driven out?

A. Yes.

Q. By the presence of the heavier liquid?

A. Yes.

Q. How did you dry it?

A. This material was then put over—in a vacuum desiccator over  $P_2O_5$ , the vacuum being renewed, oh, every twenty minutes or so, and was so kept.

Q. Now, well, you subjected it to the X-ray analysis, didn't you, Dr. Clark?

A. Yes, yes.

Q. Well, now, you didn't keep it in there when you were subjecting it to the X-ray analysis, did you?

A. No, no.

Q. Now, how did you get it out?

A. Simply was taken—the container was taken out and the sample mounted on our—on the little wedge in—the camera being in a stream of nitrogen all the time.

Q. Well,—

A. And then the X-ray pattern was made by vacuum—

Q. I am coming to the X-ray pattern.

A. All right.

Q. If you will, let me follow the process, because I have had difficulty in doing it. It was taken out of the desiccator and made into a wedge. Now, won't you tell me about that?

A. In all of this—in this work we have a—a small cradle, in which the powder is placed.

Q. In an atmosphere of nitrogen?

A. It was done in an atmosphere of nitrogen, with the extremest precaution, because of our fear of very great activity, and, in fact, we have—

Q. How cool was it when you finished drying?

A. The temperature was about—after drying in the desiccator, you mean?

Q. Yes.

A. Room temperature, 25 degrees.

Q. I see, and then will you proceed with the process, Dr. Clark, please?

A. Yes. We have, of course, a box, air-tight box for—with rubber gloves and things of that kind, that are used for unstable, mounting unstable compounds, those that absorb water very rapidly, and things of that kind, in which either very dry air, or stream of nitrogen, or  $\text{CO}_2$ , or things of that kind can be done. The sample was then with the drum, the drum of the camera—

Q. No, but I just don't get—I will come to the camera, but I am still mystified as to how you got this powder out of the desiccator and made it into a wedge. Now, it may be perfectly clear to you, such a simple process to you that you haven't made it clear to me.

A. Yes, well, we have these little—little cradles, little peaks on each end, in which the powder is placed, in this little—little holder, which can be detached entirely from the X-ray camera, and so on, and this was done by introducing the sample, sealed sample, that is, which had been kept in the vacuum desiccator, in this little stirrup or little holder, and the—by means of the rubber gloves, and the box, some of the powder was poured out into this, and with a clean porcelain edge spatula it was leveled off on the two sides, so the wedge top was formed.

By THE COURT:

Q. All under nitrogen?

A. All under nitrogen, yes.

Q. All under nitrogen?

A. Not unless there was some peculiar conditions where oxidation took place.

Q. And if you prevent oxidation?

A. I think it is perfectly safe. We use those hydrocarbons and toluene for making density tests.

By MR. WHITCOMB:

Q. Is that the toluene that Dr. Ullmann referred to in making his demonstrations?

A. Yes, and that's what we used.

By THE COURT:

Q. Well, if it corresponded to it?

A. Yes, both have hydrocarbons present, yes, sir.

By MR. WHITCOMB:

Q. I think there was some little confusion maybe about the amount in agreement and which you obtained from the centrifuge. Somewhere it got into the record as only a tenth of a gram. Was that the total amount?

A. No. We used that little bit in the chemical analysis. There have been from the various fractionations may be from the three different kinds of materials several grams.

Q. There was one question about proteins that came up. Will you please state what your position is with respect to the X-ray work in proteins as having a standard of comparison to which to turn to?

A. Proteins have been one of the mysteries and, of course, one of the most important things that we have, that we are large users of, we are large users of proteins ourselves, and in a case of that kind, although some effort can be made towards a chemical analysis of hydrogen, carbon, sulphur, nitrogen, and so on, yet no one has any idea of how those are put together. Hair and those things like that produce very

beautiful diffraction patterns. Under the leadership of Asbury, in England, and the straight-forward comparison of those, both—although no comparison of any previous standard of that kind has been made—proteins, that has been the most useful tool in determining what a protein is or that has ever discussed it.

Q. You really do rely on them?

A. Yes.

(Discussion off the record.)

By MR. WHITCOMB:

Q. Please state whether or not some of these drawings, like this one of the '151 patent or the '149 patent, or others, show the idea, diagrammatically, at least, of actually getting the air into the drum in which the metal is rotated—please refer to that and say whether or not that illustrates what you are pointing out in contradistinction to the discussion you had of this German Tudor type?

A. Yes. These diagrams show there (indicating) a pipe clear into the drum or running right up to the end of the drum, admitting or drawing air into the drum.

Q. And your idea is that this provides a means which would eliminate that chance which you say might exist in the other type, where it was just drawn around the drum, is that right?

A. Yes. This (indicating) introduces the air directly into the drum.

Q. This was the feed that you talked about in your eight grades of reactions in your original testimony?

A. Yes.

(Discussion off the record.)

were corroborated but not anything beyond his testimony.

MR. WHITCOMB: No, sir.

THE COURT: All right. That is stipulated and agreed to between the parties.

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### RETURN OF LETTERS ROGATORY.

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Examination of GENZO SHIMADZU, a witness on behalf of the plaintiffs (upon interrogatories):

*Direct examination.*

My name is Genzo Shimadzu. I'm sixty-eight years old and my present address is 420 Funayacho, Higashinotoin-dori Oshikiji-Sagaru, Nakagyo-ku Kyoto-shi. I am the president of The Nippon Denchi Kabushiki Kaisha, The Shimadzu Manufactory Kabushiki Kaisha and The Lead Pigment Kabushiki Kaisha of Japan. I have been in the business of manufacturing electric storage batteries since the year 1895, right after the Sino-Japanese War. Therefore, I have 41 years experience. I have had the same number of years experience in connection with the manufacture of lead type storage batteries. I began making the principal ingredient of the active material used in the plates of electric storage batteries of the lead type in the year 1918, therefore I have about 18 years experience.

I was first engaged in the manufacture of the electric storage batteries in Japan the year 1895; at that time I had an establishment of my own called, Shimadzu Storage Battery Manufactory. I was the owner

and directed all manufacturing processes. I owned the Shimadzu Storage Battery Manufactory. Later in January 1917, Shimadzu Storage Battery Manufactory became the Nippon Denchi Kabushiki Kaisha. At that time I was the managing director of the Nippon Denchi Kabushiki Kaisha. In the year 1926, I was made president of the Nippon Denchi Kabushiki Kaisha and am still holding the office. As I said before, it is 41 years since I started making electric storage batteries. It is 18 years since I first started the manufacture of the active materials for the plates of lead storage batteries.

The company obtained the active materials for the lead storage batteries from five stores. The names of the stores are as follows:

- Namaishi Shoten of the City of Sakai
- Nippon Paint Co. of the City of Osaka
- Kansai Paint Co. of the City of Osaka
- Abe Paint Co. of the City of Osaka
- Nippon Industrial Chemical Co. of the City of Tokyo

The active materials I used were red lead and litharge. There were three different methods of making the active materials known. The first: lead oxide is formed as a scum on the surface of molten lead. This scum is continuously removed, so that a fresh surface of the molten metal is oxidized. A yellowish gray powder may be collected, which is a mixture of the oxide and the finely divided metal. If this powder is further roasted, it is converted into a yellowish red form of lead oxide. The second: heating of metallic lead with sodium nitrate and the third: from white lead.

• I first considered the matter of making the active :



materials for the lead storage battery plates in the year 1918. As I said before, I was buying the active materials from the five above mentioned stores, but the quality of the active materials was inferior and the price was too high. Furthermore, the quality obtained differed from time to time and this, consequently, affected the uniformity of the product. Those were the primary reasons why I considered seriously making the active materials myself. I hoped to obtain chemically pure active materials of uniform quality. I contemplated the possibility of using the process of making powdered lead directly from the metallic lead, thinking this was possible because gold powder was made directly from metallic gold. In the year 1906, I sent machinery for making chinaware to Szechwan and Hunan, China, by order of the Chinese government. Among the machines I sent was a pot-mill used to powder the raw materials of chinaware. I thought the pot-mill was the machine I needed so I decided to use a small size pot-mill, made of porcelain. I made experiments on the machine, which I sold, in 1887, to Iwatsubo Gold Leaf and Gold Powder Co. for making gold dust and also on the machines belonging to the Kyoto Research Laboratories of Chinaware of Japan. The primary aim of this research was to utilize the effect of frictional shear caused by the contact of the particles of metallic lead themselves.

The experiments I carried out on the pot-mills which I borrowed from the Kyoto Research Laboratories of Chinaware of Japan, consisted in determining, the effect, by changing the revolutions per minute of the pot-mill and also the amount of feed of the particles of lead to the machine in every conceivable combination. The result was practically failure, because the lead powder produced was too coarse to be used as the active material for the lead storage bat-



teries. Furthermore, the method was too slow to be used for industrial scale production. However, I concluded there was a possibility of making lead powder just as gold dust. The above experiments were undertaken during the month of September 1918. I have no original drawing of the very first apparatus used by me in carrying out such method. I hereby certify that this (Fig. 1 attached to answers to interrogatories) is the correct photostat of the original drawing.

Ever since the time when I owned the Shimadzu Manufactory I was manufacturing machines for chinaware, especially crushers for crushing the raw materials of chinaware. Among the first machines I sold were the ones sent to Szechwan and Hunan, China, ordered by the Chinese Government in the year 1906. I experimented on the porcelain pot-mills, made for chinaware raw materials, to produce lead powder, in the year 1918. Previous to this experiment, I also experimented on the machine I sold to the Iwatsubo Gold Leaf and Gold Powder Co., to produce lead powder. This experiment was carried out during the month of February 1918, in the Iwatsubo shop in Kyoto. This is the photostat of the original drawing of the machine, this photostat is merely a reference (Fig. 3). The raw materials I used were lead balls, about one inch in diameter. The product obtained was lead powder. The pot-mill was revolved, regulating the amount of feed. The quality of the product obtained was such that it was not suitable to be used in the storage battery so I decided to experiment on some other method. These are the drawings of the machines used for the experiment, namely, the drawing of the pot-mills, I have shown you before (Fig. 1) and this (Fig. 3) I hereby certify, these are the correct photostats of the original drawings. The Fig. 2 I have shown you before was used sometime in February, 1918. The Fig. 1 and Fig. 3 were used sometime about September, 1918.

*Re-cross-examination.*

By MR. MORRIS:

Q. There's one question. If I understand you now, Dr. Clark, that has greater virtue in power in this rotating drum than if it is taken in through the periphery of the drum or the holes in the shell of the drum. Is that right?

A. I feel that the actual, directed introduction through one duct or one pipe makes positive, makes it positive that the air gets in there.

Q. It has fourteen hundred and eighty-two opportunities to get in, and if it has only one to get in, it does get in?

A. I should say, yes, through this one (indicating). It certainly does. But the other, it might or it might not.

MR. MORRIS: That's all, thank you, Dr. Clark.

(Discussion off the record.)

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MR. MORRIS: That is all the witnesses we have, I believe.

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MR. MORRIS: We want to introduce one paper.

MR. SCHAFFER: The Plaintiffs offer in evidence the draft of Dr. Wilson submitted by the Defendant, in connection—

THE COURT: Pardon me. Well, you offer all your exhibits, don't you? You have already, I guess.

MR. SCHAFFER:—submitted by the Defendant at the Plaintiffs' request.

THE COURT: I will assume that all the exhibits have been offered, by both sides, and all will be received, except those objected to.

MR. BETTS: If your Honor please, we also have outstanding the letters rogatory on deposition that was sent to Japan of Benzo Shimadzu, Tominosuke Hichijo, and Suyeharu Uchiyama.

(Discussion off the record.)

MR. MORRIS: I am willing to stipulate that if they are delivered in three weeks period, but I don't believe that those things ought to be taken at this stage of the case. Of course, they are in chief and, in fact, the dates, so far as any dates can be fixed, have been fixed.

(Discussion off the record.)

MR. MORRIS: Suppose I reserve the right to object to them when they come in.

THE COURT: All right, I will have that in mind. Can't we get this? Could it be stipulated that the testimony contained by these letters rogatory will not be offered in evidence for any purpose except in corroboration of Mr. Ishimura's testimony in this proceeding?

MR. WHITCOMB: Absolutely, we will be glad to.

MR. MORRIS: Also, the Defendant will be allowed to object to them on any ground?

THE COURT: Yes. I say we could go ahead and assume that that's what they will do when they get here, and we will proceed as though he

As I said before, the qualities of the materials produced were such that the particle size was too coarse, the apparent specific gravity being 3, to be used as raw materials in the storage batteries. The amount produced was also too small to be satisfactory for industrial scale production.

Next I experimented on a mortar type of vertical grinding mill to further powder the coarse particles of the lead previously prepared. I have no original drawing of the above mentioned machine. I hereby certify that this is the correct photostat of the original drawing (Fig. 4).

The method I employed next was that of using a revolving wooden cylinder made of cryptomeria. The revolving wooden cylinder I used had an orifice from which the product was obtained. The raw material, fed to the revolving wooden cylinder, consisted of lead balls about one inch in diameter. By regulating the feed, the quantity of product was determined. The particle size of the product thus produced was fine enough but the product was contaminated with small wooden fragments from the cylinder. The color of the product was greenish gray. This method was tried in the laboratory of the main factory of the Nippon Denchi Kabushiki Kaisha during the month of September 1918. The lead powder produced by this method was very fine in particle size, the apparent specific gravity being less than 2. The conclusion drawn from the above experiment enabled me to visualize the possibility of employing this method to produce finer lead powder for the storage battery. The objection was the wooden fragments mixed in the product. The attached is the correct photostat of the drawing of the machine used (Fig. 5). I experimented further with a drum made of iron. I experimented further on a drum made of iron. The drum was 60 inches in diameter and 60 inches in length. Lead balls were first introduced into the iron cylinder through

an orifice, then the drum was revolved. The most advantageous point as to the number of revolutions per minute and the amount of feed were experimentally determined and the percentage of the output was 1% of the input per hour. The pulverized lead thus produced had the apparent specific gravity of 2.4. I carried out this experiment in the branch factory of the Nippon Denchi Kabushiki Kaisha during the month of December, 1918. Attached is the correct photostat of the original drawing of the drum mentioned above. The reason I cannot attach the original drawing is that I have only one original drawing on hand (Fig. 6). The speed of the revolving drum was about 14 revolutions per minute.

The next thing I did I effected separation of the finer powder from the coarser powder by means of an air current. This experiment was also carried out in the branch factory of the Nippon Denchi Kabushiki Kaisha during the month of December, 1918. The separation of the finer lead powder from the coarser lead powder by mechanical means was possible, but the method has no industrial value because I had no use for the coarse powder of lead left behind. The attached is the correct photostat of the original drawing (Fig. 7). In order to secure a finer and better lead powder, I next tried the Buhr stone mills made in France. This experiment was also carried out in the branch factory of the Nippon Denchi Kabushiki Kaisha, during the month of December, 1918 (Fig. 8). The machine with which I experimented next was a horizontal grinder. I drew the conclusion, from using those machines, that mechanical means of making a finer powder was impossible. The attached are the correct photostats of the original drawings of the machines used. (Fig. 8 and Fig. 9.)

I did not try in any previous trials to introduce

air into the rotating drum. I first came to experiment with the introduction of air when, one day, while I was doing an experiment, I saw very fine lead powder piled up on the bearing bracket of the grinding machine. Then and there I thought of introducing air to effect the separation of the finer lead powder from the coarser. This is the correct photostat of the original drawing showing the machine so used. The original drawing was drawn by Mr. Luyho Ishimura, an engineer of the Nippon Denchi Kabushiki Kaisha on the 26th day of December, 1918 (Fig. 10) at the Nippon Denchi Kabushiki Kaisha. Figure 11 is the correct photostat of the original drawing of the blower.

I ordered the machine from the Mitsubishi Ship Yard of Kobe, naming it as a drum, and received same in November, 1918, at the Nippon Denchi Kabushiki Kaisha. I do not know whether the Mitsubishi bought their materials required for the construction of the above mentioned drum. The machine was assembled, under the direction of Engineer Luyho Ishimura, for operation in the branch factory of the Nippon Denchi Kabushiki Kaisha during the month of November, 1918. I first operated above mentioned machine using the iron plate drum with the air inlet tube during the month of December, 1918, at the branch factory of the Nippon Denchi Kabushiki Kaisha. On the 26th day of December, 1918, I ordered Mr. L. Ishimura to make the drawing of the assembled machine. This is the correct photostat of the original drawing (Fig. 12). The notary Yasugoro Abe's sign indicating No. 6605 was obtained September 30, 1919, on the drawing (Fig. 12) to avoid trouble in future. I introduced lead balls, about one inch in diameter, into the horizontally and revolvably mounted cylinder; within this cylinder was fitted a brass piping, an extension of the air blower, 1.5 inches in diameter, provided with small holes. The air



from the Roots blower was blown into the cylinder through the small opening. The color of the product obtained was black and was fine enough in texture to be used in storage batteries. The ratio of output was, 12.42 pounds to the feed of 1987.2 pounds, per hour, or equivalent to 0.66%. The primary reason of this small rate of output was due to the lack of knowledge necessary for the proper operation. The air blower I used was the Roots blower. The amount of charge of raw materials was 1000 kilograms of lead balls of 1.5 inches in diameter, together with 500 balls of steel, 1 inch in diameter. Air blast having a pressure of 21 inches of water was sent out of the air blowers; the volume of air used was 800 cubic feet per minute. The speed of the revolving cylinder was 15-25 revolutions per minute. The fine lead powder, produced in the cylinder was blown out of the cylinder through the discharge orifice, by means of the air current from the above mentioned air blower; the lead powder thus blown out was led into a collecting chamber. The collecting apparatus were made of 6. or 7. cotton bags, about 10 inches in diameter and 10 feet in length. These were each fitted air tight to the uncovered top of the steel boxes, each of which was connected to the main exhaust line; thus, the air carrying fine powder produced in the cylinder, passed through the cotton bags leaving the lead powder behind in the box. The lead powder collected in each box was removed from time to time (Fig. 15). Figure 15 as a reference. The temperature inside the drum was around 60° C. The temperature was determined by a mercury thermometer and controlled by regulating, by means of a valve, the amount of air blown into the drum. This is the correct photo-stat of the original drawing of the last mentioned successful complete installation (Figs. 13 & 14). Assembly drawing fig. 14 as a reference.



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As the result of industrial scale experimental research, I carried on from March, 1919, to the spring of 1920, on the machine, I finally succeeded in collecting necessary data, as to the best speed, the best amount of air to be blown in. Furthermore, I made improvements on the air line inside the cylinder by introducing jets. I also determined how and how much the temperature inside the cylinder affected the quality of the product. Finally in June, 1920, my superhuman effort was rewarded materially. The batteries made from my product were high in dependability and long in life. From June, 1920, on, it was definitely established that the production could be carried out industrially as well as economically. The produced lead powder was extremely fine in its particle size and chemically very active. I discovered that it oxidized spontaneously in air and that if a few drops of water were dropped on it, oxidation commenced instantaneously, changing the black lead powder into yellow litharge. I also discovered that, during the experiment, the extremely fine lead powder, if damp, ignited freely on contact with open flame; especially reactive was the powder made at around  $100^{\circ}$  C, and at this temperature, I found that the yield increased many fold. The data taken in the temperature-yield experiment showed that, up to a certain point, the temperature and the yield increased proportionally. Thus the best results could be obtained if the temperature inside the drum was kept constant at a certain temperature, during the operation. The incoming air when it came in contact with the surface of the lead ball oxidized the metallic surface; as soon as the surface was oxidized, the friction and abrasion reduced the oxide into powder and formed new surfaces on the lead pieces. The fine powder thus formed was suboxide, perhaps high in metallic lead content. I discovered at this

point that the product, on natural oxidation changed easily into litharge. On 17th of December, 1920, I filed my first application, No. 431,473 to the Government of the United States of America on the method of manufacturing litharge from very reactive lead powder. I thought this process, that is: the surface of the metallic lead being caused to be acted upon by the air or other oxidizing agent, and to be covered with a coating of lead oxide, which being brittle and lacking tenacity compared with metallic lead, can be easily and quickly reduced into powder by abrasion, and as soon as a new metallic surface of the pieces appears, it being instantly oxidized and abraded, thus continuously producing the desired powder, was a great discovery, especially the experiment proving the phenomenon of oxidation of powdered lead in air, so I thought it was a worthwhile discovery to obtain foreign patents.

I started the industrial scale research in the process described in the U. S. Shimadzu patent No. 1,584,149, in March, 1919, using an iron cylinder 60 inches in diameter, and 60 inches in length, and an air blower.

As claimed in 1: a method of forming a finely divided and chemically active lead powder, which comprises introducing relatively large masses of lead into a rotatable vessel, rotating and forming lead powder by rubbing of the masses against each other.

In Claim 1: I showed that even if the air supply was momentarily stopped the chemical reaction will not stop because there is enough air present in the drum, in other words, I claimed that, this process could be carried out in atmosphere as well as under pressure.

In Claim 2: including the method mentioned in Claim 1, and introducing a current of air into the drum and removing the lead powder formed by rub-

bing the lead masses against each other from the drum by means of the current of air.

In both methods, steel balls were used to accelerate the operation.

From June, 1920, on I was performing experiments in the newly built lead powder factory, producing at the same time for commercial purposes. The method comprising in putting in a rotatable drum pieces of metallic lead, keeping these pieces at a temperature high enough so the incoming air readily oxidizes the surface of the lead pieces and reduces them by abrasion into a very fine powder, which is chemically very reactive; the lead powder thus formed is carried with air current through the opening in the one end of cylinder, into a suitable chamber.

The rate of production increased gradually as the necessary data on the process were determined. Finally, in 1921, successfully reaching as high as 100 pounds per hour.

Contrary to the belief held before, I discovered that the lead powder thus produced contained primarily lower oxides of lead and only a few percent of metallic lead. In 1922 I began exact qualitative analysis of the product.

The present rate of production is a little over 800 pounds per hour.

Claim 1 of U. S. Shimadzu Patent No. 1,584,150 claims especially: 1. A process of manufacturing a fine powder of lead sub-oxide (lower lead oxides) intermingled with powder of metallic lead comprising in putting pieces of metallic lead in a rotatable vessel, introducing into the vessel currents of an oxidizing gas to oxidize the surface of the lead, while rotating the vessel and abrading off the oxides formed on the surface.

Claim 2 of U. S. Shimadzu patent No. 1,584,150 claims especially:

Introducing into the vessel, mentioned in Claim 1, while rotating blasts of a gas containing oxygen, such as air, causing such blast to blow the powder produced out of the vessel.

Claim 3 of U. S. Shimadzu patent No. 1,584,150 claims especially:

A process of manufacturing a fine powder of sub-oxide intermingled with powder of metallic lead comprising in putting pieces of metallic lead in a dry state into a rotatable vessel, and delivering an oxidizing gas into the vessel while revolving the vessel.

Claim 4 of U. S. Shimadzu patent No. 1,584,150 claims especially:

A process of manufacturing, described as above, and rotating the vessel maintaining the temperature within the vessel at not less than  $60^{\circ}$  C., at the same time introducing into the vessel an oxidizing gas.

Claim 6 of U. S. Shimadzu patent No. 1,584,150 claims especially:

A process of manufacturing, described as above, and stressing the importance of maintaining the temperature of the material at not less than  $60^{\circ}$  C., by the heat generated by friction and chemical action.

8: In the production of a finely divided mixture of sub-oxide and metallic lead, the step of tumbling together and agitating a mass of hard heavy material containing metallic lead, while maintained at a temperature between about  $60^{\circ}$  C. and  $100^{\circ}$  C.

Claims 9-13: A method of forming a finely divided lead powder described as above and paying of special attention as to the regulation of the speed, the feed and the temperature.

The temperature inside the vessel is gradually raised as the vessel starts rotation. As the temperature approaches the desired maximum point, the percent content of the metallic lead and oxides of lead in the product changes gradually, that is to say, there is formed in the product oxides of lead and metallic lead in a form of powder, the oxides predominating.

From the Spring of 1919 to the beginning of 1920, I often experienced producing a yellowish powder, especially on a rainy day. The cause was found to be the moisture carried with air into the drum through the jets, from the outside.

This caused further oxidation to take place and generated much heat, changing the produced powder into yellow oxide of lead.

When the yellowish powder was ignited in an open crucible, a reaction took place, generating much heat and changing the whole masses into yellow litharge.

The U. S. A. Shimadzu patent No. 1,584,151 was based on this principle.

Claim 1 stresses:

A process of forming finely divided oxygenated lead compounds which comprises treating a finely divided chemically reactive powder comprising major portion of lead suboxide with an oxidizing substance, stressing the industrial importance of utilizing the heat of reaction, initiated by the humid air used.

Claim 2 stresses:

A process of forming finely divided oxygenated



lead compounds, which comprises treating a finely divided chemically reactive powder comprising lead suboxide and metallic lead powder with an oxidizing substance, and maintaining the reaction by the evolved heat of reaction.

Claim 3 stresses:

The process of forming a finely divided oxygenated lead compound which comprises powder comprising a major portion of lead suboxide with an oxygen containing substance and continuing the reaction by the evolved heat of reaction.

Claim 4 stresses:

The method of forming finely divided lead oxide which comprises treating a finely divided chemically reactive powder, comprising a large proportion of metallic lead with air, and continuing the reaction by the evolved heat of oxidation.

Claim 5 stresses:

The method of forming a finely divided oxygenated lead compound which comprises contacting finely divided chemically reactive powder comprising a major proportion of lead suboxide with moisture and continuing the reaction by the evolved heat of reaction.

The product mentioned in U. S. A. Shimadzu patent No. 1,584,150 is similar to the product mentioned in the U. S. A. patent application No. 431,473 filed and withdrawn December 17, 1920, namely chemically very reactive lead powder.

The processes claimed in U. S. A. Shimadzu patent No. 1,584,150 Claims 14, 15, 16 and 17 were based on the properties of product peculiar to the product obtained from the spring of 1919 on.



The Japanese Patent Law requirement on inventions stresses the importance of priority. After I started the experiments on the making of the lead powder I partly completed the process in the spring of 1919, and in 1920, when I almost completed the industrial process, I filed an application for the Japanese patent on the above discovery in December, 1920. Thereafter, on discovery of each improvement, I filed an application for each improvement. These patents are all more or less based on the Japanese Shimadzu patent #41,728 filed on the 21st day of November, 1920.

On almost all applications filed the patents were granted; some of them as an improvement in parallel to the Japanese Shimadzu Patent #41,728 and some as separate patents, all on the process of making the lead powder.

The Japanese patents were obtained, some of them through a lawyer and some of them by filing applications myself.

The patents applied for in the United States are more or less on improved methods based on the Japanese patents. Therefore, the dates set on the U. S. Shimadzu Patents might not coincide with the dates of the Japanese Shimadzu Patents. Similarly, the claims of the U. S. Shimadzu Patents may not be the same as the claims of the Japanese Shimadzu Patents.

The date of filing my application on the U. S. Patents in Japan, I firmly believe should be under the jurisdiction of the United States patent law.

The United States Shimadzu patents were obtained through Mr. Morio Nakamatsu, a Japanese lawyer of Tokio. I also obtained my Japanese patents through him, and this previous knowledge and experience enabled him to translate what I have told him orally about the invention.

Those patents were applied through the firm of Marks & Clerk of Washington.

As has been previously answered in interrogatory (4-11) the United States patents, obtained on the processes and methods of making the lead powder, were seriously considered and then condensed before faking out each separate patent.

As to the conceptions and experiments on the technical information, which has been stated in the Interrogatory (4-11) I aimed in the beginning to produce a very fine lead powder for storage batteries. As the experiments progressed, the lead powder produced was not exactly ordinary lead powder but chemically a very reactive lead powder, differing greatly in properties from the ordinary lead powder.

If dampness permeated this powder in the air, I experienced that it, when ignited, changed the lead powder into yellow litharge.

At first I thought the lead powder produced at low temperature was metallic lead, fine in its particle size, but after many experiments I found that if an air nozzle is inserted into the cylinder and air blown through while the cylinder was rotating, and the temperature kept high, the powder produced was more reactive while at the same time the rate of production increased enormously. I concluded from this phenomenon that the lead powder produced consisted of lower oxide of lead. Believing this to be the case, I analyzed the powder and finally confirmed the opinion that the lead powder was suboxide of lead; but, upon further analysis, the lead powder produced was equivalent to a mixture of suboxide of lead and small amount of metallic lead.

The reason why I treated the product as suboxide of lead in the United States Shimadzu Patent #1,584,150 was that at that time the product obtained was only

known as a very low oxide of lead. On determining further the properties of the product, as can be seen in the later patent, I found the ingredients of the product to be similar to the ones mentioned in the later patent. With a substance such as lead which changes its properties with temperature and is unstable in air, it is very hard to determine its exact identity.

I know Mr. C. Reed Carey, because I met him in Kyoto. When Mr. Carey came to Kyoto in February of 1926 he came to the Shimadzu Manufactory, of which I am the president, and offered to the firm, the exclusive right of handling his company's product in Japan. Mr. Carey came to the Shimadzu Manufactory on his own accord on the subject mentioned above in February 1926. I directly heard the proposal from him.

After the greeting, I talked to Mr. Carey about my invention on the lead powder and told him that this powder, if used in storage batteries, will greatly improve the general qualities of the batteries. Then he told me that he had a good friend in the biggest storage battery company in the United States of America. He said he would tell them and ask them to use my products.

So I told him that if they wished, I would be glad to sell my patent rights in the United States of America. I showed him my factory and explained to him the process.

I took him to the branch factory of the Nippon Denchi Kabushiki Kaisha, and explained to him, while the machines were in operation, the size, the conditions of maintaining operation of machines, the air-blowing device, collecting chamber systems, and general conditions of the factory.

I gave Mr. Carey summary of processes of making lead powders, one with a circular explaining the ad-

vantages of using my products in the storage battery, and few others.

I do not remember exactly every circular I gave Mr. Carey then, but this is one of the circulars I gave Mr. Carey (Fig. 16). I gave Mr. Carey Lead powder, red lead, and litharge as samples. At that time Engineer Luyho Ishimura was in Berlin, Germany. He was to return to Japan through the United States, and taking advantage of the situation, therefore, I told Mr. Ishimura to visit Mr. Carey and talk about the matters concerning the subject. Mr. Ishimura reached the United States in June, 1926, and visited Mr. Carey in Philadelphia, Pennsylvania. Mr. Cary told Mr. Ishimura that he (Mr. Carey) told all about the Shimadzu process to his good friend, Mr. Smith, who is the chief engineer of Exide Company, the defendant in this litigation. Mr. Carey introduced Mr. Ishimura to the President and to the Directors of the Exide Company and Mr. Ishimura discussed the matter of business transaction with them many times. The details as to the matter discussed on the subject can be readily recalled by Mr. Luyho Ishimura, who is at present in the United States. These are the photostats of the original copies of letters exchanged with Mr. Carey at that time. (Fig. 17.) I firmly believe that I was the first one to discover the process of making a fine powder of oxides of lead so as to cause natural oxidation in the air and their production on an efficient industrial scale in a simple way. Japanese patents which are generally very difficult to obtain were granted for all my processes on account of the great value attached to the invention, especially of proving that lead powder oxidizes in the air. I was selected from amongst countless inventors as one of the ten greatest inventors of Japan, and was invited to the dinner reception given by the Emperor of Japan. This alone shows, I believe,

the real value of my invention. Subsequently, my inventions appeared in many books and magazines.

The names of the books and magazines are as follows:

Gmelin-Kraut's Handbuch der Anorganischen Chemie", Band IV. Seite 809, u. 845.

Prof. Dr. Fritz Ullmann "Enzyklopadre der technischen Chemie" Seite 512 u. 523.

Prof. C. Drucker und Dr. A. Finkenstein, "Galuanische Elemente und Akkumulatoren" Seite 165.

J.W. Mellor, D. Sc. "A Comprehensive Treatise on Inorganic and Theoretical Chemistry" pages 514, 637-639, and 644.

Revu General L'Electricite, vol. 16, No. 20, page 792.

YuKichi Osachi D. Sc., Tsuzoku Kagaku Taiwa, pages 351-353.

Prof. Sonosuke Mori "Chuto Sinsei Butsurigaku Kyokasho" page 284.

Kogyo Kyoiku Kenkyukai and Shoko Chushinkai "Kaitei Butsurigaku" page 194.

I wish to say on account of the fact that my applications in the United States have been properly arranged from past improvements in connection with many Japanese patents there is not a single United States patent of mine that is identically the same as any of my patents in Japan.

Lastly I would like to say that the Mr. Hall who invented the machine used by the Exide Company, who are the defendants in this case, joined that Company in 1920; all this I understand.

Now, any invention takes a great deal of time and energy. In order to complete the invention, first an

idea is formed in the inventor's mind; it undergoes stages of mental development. Then it materializes, then it is made into a model in crude form, and requires many improvements and years of hard work. Even the greatest genius cannot in such a short time complete inventions of machines or processes, such as this, as is claimed to have been accomplished by Inventor Hall.

The date of filing my first application is not exactly the day when I completed my inventions, but even so, it was in August of 1920. This alone should prove the priority of my claim.

*Cross-examination.*

I have not manufactured nor have been connected with the manufacture of lead type electric storage batteries in any country outside of Japan. I have had no connection whatsoever with any battery company in Japan which was subsidized by the Japanese Navy or Arsenal.

I am President of the Nippon Denchi Kabushiki Kaisha. The Nippon Denchi Kabushiki Kaisha does not belong to the Mitsubishi concern. The Mitsubishi concern is merely one of the shareholders. The Nippon Denchi Kabushiki Kaisha was organized in January, 1917. The Shimadzu Storage Battery Manufactory owned by me since 1895 was sold to the Nippon Denchi Kabushiki Kaisha, when the Nippon Denchi Kabushiki Kaisha was organized, and I have been connected with the company ever since the company was organized. I have had no connection whatsoever with the Yuasa Chikudenchi Seizo Kabushiki Kaisha. As far as my knowledge is concerned the companies named in questions 7 and 8 have no connection with the Japanese Navy or any Departments thereof in or in connection with the improvements of submarine ac-



cumulators. I have known Engineer Commander Hikoschiro Miida when he was on the active list, but I have no knowledge of his whereabouts at present. I have no knowledge whatsoever of any approach made by Mr. Miida to Mr. Andresen, the representative of the Accumulatoren Fabrik Aktiengesellschaft because in no way was Mr. Miida connected with me.

I know of Mr. Miida's visit to Europe prior to 1922, but I have no knowledge whatsoever of his doings in Europe. Mr. Miida has not been in my employment nor in the employment of any company with which I am connected.

**FOURTEENTH CROSS-INTERROGATORY:** Is it not a fact that prior to undertaking the manufacture of the product described in the patents in suit, more particularly in patent #1,584,150, you directly or indirectly approached or negotiated with the Accumulatoren-Fabrik Aktiengesellschaft for the acquisition of apparatus or plans of apparatus for making in Japan the materials for lead dust which the Accumulatoren-Fabrik Aktiengesellschaft used in the manufacture of its batteries?

**ANSWER:** On the 5th day of February, 1920, I was approached by the Ellis Company of Berlin on the apparatus referred to in question, but I was not interested in the matter, because of completion of my invention previous to this date.

Later, when I filed an application for German Patent on my invention, the German Patent Department sent a drawing of machine made by the Accumulatoren-Fabrik Aktiengesellschaft. The date of mailing of above drawing was May 11, 1925. This is the copy of above drawing (Fig. 18).

I started the manufacture of storage batteries right after the Sino-Japanese War in 1895. During



the Russo-Japanese War I sold my product for military use in Japan. Thereafter the demand for batteries increased. In order to meet this increased demand, it was no longer possible to depend on the raw materials supplied by others, because of lack of uniformity of product made from raw materials obtained from various sources. This necessity forced me to try some means of producing lead powder directly and quickly from the metallic lead. The experience and knowledge I acquired through long years of practice on the matter, required no knowledge from others nor the methods employed by others in Europe.

The porcelain pot-mill referred to is a machine used in crushing raw materials for chinaware, 6 inches in diameter and 10 inches in length.

The Nippon Denchi Kabushiki Kaisha does not engage in handling storage batteries made by others, but the Shimadzu Manufactory with which I also am connected, handles, since the beginning, all forms of apparatus, such as, machines of all makes, scientific apparatus used in laboratories, electrical appliances and X-ray sets made in foreign countries, including storage batteries for automobile use; naturally, we were the agent in Japan, representing such American company which deals in automobile storage battery. As has been said before the Import and Export Department of the Shimadzu Manufactory was once engaged in handling storage batteries, representing American concern for automobile uses. In 1918, we were the agent of Willard Storage Batteries Company of Cleveland, Ohio, U. S. A. I have not bought any storage batteries from the Accumulatoren-Fabrik Aktiengesellschaft. As I said in previous answer, I know of the construction of the machine used by the Accumulatoren-Fabrik Aktiengesellschaft because when I applied for German Patent, the German Patent Depart-

ment sent me a drawing of the machine but as to the lead ingredient or oxide used in the plates of storage batteries or process of same I had no idea. As has been mentioned before, the Shimadzu Manufactory represented the Willard Company of America from December 12, 1918 to June 28, 1934, in Japan.

The Shimadzu Manufactory handled batteries made by Leeds & Northrup but we were not the agent representing Leeds & Northrup in Japan, although vice-president Carey of Leeds & Northrup approached us on the matter of representing their product exclusively in Japan; we refused the offer. I did not meet Mr. Carey in Japan in the first instance for the purpose of discussing a proposed business arrangement between my company and Leeds and Northrup of Philadelphia. On account of my being the president of Company, it was merely incidental that I met Mr. Carey when he visited the Shimadzu Manufactory in Kyoto, Japan; although Mr. Carey talked on the subject to some of my men in the factory, I refused the offer. After the greeting, I talked to Mr. Carey about my invention on the lead powder and told him that this powder, if used in storage batteries, will greatly improve the general qualities of the batteries. Then he told me that he had a good friend in the biggest storage battery company in the United States of America. He said he will tell them and ask them to use my product, so I showed him my factory, explained to him about the apparatus and gave him a few circulars explaining the process and told him that if they wished, I will be glad to sell my patent right in the United States of America.

Mr. Luyho Ishimura was in my confidence in connection with the subject matter of my testimony and I disclosed freely and without reserve all details to him.

The United States Shimadzu patents were ob-

tained through the Nakamatsu Patent firm. The details of process were explained orally, therefore I have no drafts or memoranda or notes written in Japanese language.

SUYEHARU UCHIYAMA, a witness called on behalf of plaintiffs, having been first duly sworn, testified as follows:

*Direct-examination.*

My name is Suyeharu Uchiyama. I am forty-four years old. My present home address is 31 Koyamamoto-Machi Kamigyo-ku, Kyoto-shi. I am a member of Nippon Denchi Kabushiki Kaisha. I know Mr. Genzo Shimadzu and Mr. L. S. Ishimura. I have known them since the time I joined the Nippon Denchi Kabushiki Kaisha July 22, 1918.

Ever since I entered the Nippon Denchi Kabushiki Kaisha in July 22, 1918, I worked under Engineer Ishimura, who, under direct supervision of Mr. G. Shimadzu, was the engineer of the Nippon Denchi Kabushiki Kaisha. I was hired as a draftsman on July 22, 1918, by the Nippon Denchi Kabushiki Kaisha with which firm, Mr. Shimadzu was already then connected. As I said before, I entered the Nippon Denchi Kabushiki Kaisha on July 22, 1918, and worked as an assistant to Engineer Ishimura.

My routine work and duty was to make, trace or sketch drawings as directed by Engineer Ishimura. I have been making drawings of apparatus and machines used by Mr. Shimadzu in connection with the manufacture of storage batteries of the lead plate type and therefore, I have general idea of the work which has been carried on by Mr. Shimadzu.

## FOURTH INTERROGATORY:

I remember the two drawings which Mr. Shimadzu had made very well because I actually saw Engineer Ishimura draw up plans for the construction of apparatus for making lead powder from lumps of lead in which revolving horizontal cylinder was used. The dates were sometime in September, 1918 and December, 1918. On account of the rule of the company, I cannot attach the original drawings. The attached are the correct photostats of the original drawings obtained through the courtesy of President Genzo Shimadzu (Fig. Uchiyama A) (Fig. Uchiyama B). The first drawing was planned, designed and traced by Mr. Ishimura, and I only blue printed the drawing; therefore, my signature is not on the first drawing. The second drawing was planned and designed by Mr. Ishimura, and I traced it on December 26, 1918; therefore, my signature, S. U. is on the drawing. Previous to the time the drawings were made, Mr. G. Shimadzu was working day and night on the problem of solving a method to produce the lead powder from metallic lead. In September, 1918, upon the completion of process, Mr. G. Shimadzu ordered Engineer Ishimura to make the drawings of apparatus on industrial scale. As I said before, the first drawing was made entirely by Mr. Ishimura, and I only did the blue printing. I actually saw him make the drawing some time during September, 1918. The second drawing, as I said before, was planned and designed Mr. Ishimura and I did the tracing on December 26, 1918. The two drawings were made by Mr. Ishimura under the direct supervision of Mr. G. Shimadzu and in blue printing and tracing above drawings, order was given me from Mr. Ishimura to do them quickly and secretly. The first drawing shows the important parts of revolvable iron cylinder, and the second drawing shows the revolv-

able iron cylinder equipped with 1.5 inch brass air pipe. Both drawings concerning machine for making the lead powder.

#### FIFTH INTERROGATORY:

There were sketches made by me previous to the two drawings referred to in the fourth interrogatory, based on the tests made by Mr. Ishimura under the direct supervision of Mr. G. Shimadzu. The first tests were performed on potmill made of porcelain; the next tests were performed on revolvable drum made of wood. General sketches of apparatus assembled were made as has been described in Mr. Ishimura's document "Investigations on making of Lead Powder". These drawings were designed by Mr. Ishimura under the direct supervision of Mr. G. Shimadzu and traced by me per instruction given by Mr. Ishimura. As has been said, I made or traced drawings per instruction given by Mr. Ishimura who performed tests under the direct supervision of Mr. G. Shimadzu. The drawings are in a document called "Investigation on making of Lead Powder" held by Mr. Ishimura. These are the correct photostats of the drawing obtained through courtesy of the President, G. Shimadzu (Fig. E). These drawings are the assembly drawings of the apparatus used for making the lead powder. Dimension and details are as shown on the drawing.

I knew of the apparatus based on these drawings being used for making lead powder, which in turn is made into paste to be used for the plates of storage batteries. I was working under Engineer Ishimura ever since I entered the firm and, by this reason, I was familiar with the above drawings. Consequently, I knew of the fact that machines were assembled according to the drawings (Fig. A & B). The apparatus based

on the first drawing was assembled in early part of November, 1918. The apparatus based on the second drawing was assembled in January, 1919, in the machine department of Shimadzu Mfg. The first and the second apparatus was used to make the lead powder for the plates of storage batteries. The first apparatus was operated in early part of November, 1918, and the second one was used in January, 1919, both dates being such as far as I remember. I did not know of the first test on the machine being performed because tests were carried on secretly, but in latter part of November, 1918, when I went to the lead powder factory to obtain some information on the drawing then being made, I saw a machine resembling that of the first drawing. I actually saw the apparatus, that is, the one equipped with air blower in operation in January, 1919. Lead balls about one inch in diameter were introduced into the machine through a feeder. I actually saw dark lead powder produced by this machine. The collecting mechanism of the first machine was an iron box installed under the revolving cylinder. The collecting process of the second machine was effected by the air which carried the product produced in the cylinder into the collecting chambers where it was deposited. The lead powder produced in the machine was used to make paste for the plates of storage batteries.

Ever since I entered the firm of the Shimadzu Manufactory in September, 1918 I have been working directly under Engineer Ishimura who, under the direct supervision of Mr. Shimadzu was working on a process of making lead powder from the metallic lead. As the result of Mr. Shimadzu's diligent research, the lead powder produced from metallic lead mechanically revolutionized the world's storage battery production. I was not connected in the detail part of the research, but I had a general idea of its dates and progress be-



cause I had made drawings concerning it under the instruction of Mr. Ishimura. Of the data and record shown in a document called "Investigation on Making of Lead Powder", held by Mr. Ishimura, I can swear and affirm to be the truth.

TOMINOSUKE HICHIO, a witness called on behalf of plaintiffs, having been first duly sworn, testified as follows:

*Direct-examination.*

My name is Tominosuke Okamoto. My former name was Hichijo which I legally changed five years ago. My age is fifty-two years. My present address is 250 Hozuicho, Shiramori-Dori Shimodachuri-Agaru, Kamigyo-Ku, Kyoto-shi. I am foreman in the Nippon Denchi Kabushiki Kaisha. I know Mr. G. Shimadzu and Mr. L. S. Ishimura very well. I have known these men ever since I entered the firm in November 23, 1918. I have been working in the Nippon Denchi Kabushika Kaisha under Engineer Ishimura ever since my joining the firm. Mr. Shimadzu is the president of the company.

I joined the Nippon Denchi Kabushiki Kaisha on November 23, 1918. Mr. Shimadzu is the president of the company. I have been employed by Nippon Denchi Kabushiki Kaisha from November 23, 1918 to the present date, namely, 19 years. In the beginning I was a actory hand, working on the operation of mills.

I was an assistant to Engineer Ishimura in operating mills. I also worked on various experiments under the direction of Engineer Ishimura and Mr. Shimadzu. I operated the drum. I knew the apparatus was used to produce lead powder from metallic lead. The apparatus was intended to be used for producing



lead powder. The metallic lead balls were fed into the drum which was revolved. This apparatus was first completely assembled in early part of December, 1918. In the first apparatus which was constructed of iron cylinder, the lead balls were fed into the drum which was revolved. Through the opening in the drum, the lead powder produced was collected under the drum in a box. The powder produced was very coarse. Later, when the drum with pipe was used, the product obtained was collected through an air line and was very fine in texture. The dimensions of the drum were sixty inches in diameter and sixty inches in length, as far as I recall.

(At this point the Judge showed Mr. Okamoto the drawings Uchiyama A & B.)

#### FOURTH INTERROGATORY:

I have seen these drawings before. I saw the first drawing (Uchiyama A) in December, 1918, and the second (Uchiyama B) in the spring of 1919. The drawings are of the apparatus I operated as I mentioned before.

#### FIFTH INTERROGATORY:

I actually operated the apparatus made from these drawings referred to in the Fourth Interrogatory. I first saw the first apparatus operated in December, 1918 and the second sometime after January, 1919. I operated both apparatus in a branch factory of the Nippon Denchi Kabushiki Kaisha. I know of the raw materials used in that apparatus. They were lead balls about one inch in diameter; steel balls were sometimes used with the lead balls. I actually saw the lead powder produced by the apparatus. The product obtained from the first apparatus was coarse lead pow-

der, but the product obtained from the second apparatus was much finer lead powder.

I remember of the incident when Mr. Shimadzu found very fine lead powder piled up on the bearing bracket, and of the fact that he conceived the idea of using air current from this to separate the finer from the coarser lead powder. I also recall the incident when in the fine lead powder collected in a wooden box, a spontaneous combustion occurred.

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UNITED STATES OF AMERICA

CITY COUNTY AND STATE OF NEW YORK } ss:  
SOUTHERN DISTRICT OF NEW YORK :

Wasuke Tanaka, being duly sworn, deposes and says that he is well acquainted both with the Japanese and the English languages, and that during the month of April, 1936, he translated the answers to the direct and cross interrogatories addressed to the witness, Genzo Shimadzu, and the answers to the direct interrogatories addressed to the witnesses Suyeharu Uchiyama and Tominosuke Hichijo in the above cause, from Japanese into English, and that his translation thereof is a true and accurate one to the best of his ability.

WASUKE TANAKA.

Sworn to before me this  
14th day of May, 1936.  
(SEAL)

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STIPULATION:  
(Filed April 19, 1937.)

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Whereas, the respective parties in the above-entitled cause have separately appealed from the inter-

locutory decree of the United States District Court for the Eastern District of Pennsylvania entered in said cause on .

It Is Hereby Stipulated And Agreed by and between counsel for the respective parties as follows:

1. That the statement of testimony and evidence taken upon the trial of the above-entitled cause, in the condensed narrative form thereof hereto attached, may be approved by the Court, and, subject to the approval of the Court, become a part of the transcript of record to be certified to the Circuit Court of Appeals for the purpose of both appeals, lodgement of said condensed narrative statement in the Clerk's office and notice thereof and of the presentation thereof to the Court being hereby waived.

2. That subject to the approval of the Circuit Court of Appeals, the exhibits introduced upon the trial of said cause, susceptible of reproduction, may be omitted from the printed record on said appeals, said exhibits, however, to be submitted upon said appeals as physical exhibits in the form of five bound copies of reproductions thereof.

3. That the cost of preparation, certification and printing of the transcript of record to be certified to the Circuit Court of Appeals in connection with said appeals shall be divided and paid equally by the parties in the first instance, and thereafter adjusted in accordance with the taxable costs as provided by the mandate of said Circuit Court of Appeals.

RAWLE & HENDERSON,  
EDWARD B. WHITCOMB,  
HUNT, HILL & BETTS,  
*Counsel for Plaintiffs Appellant.*

AUGUSTUS B. STOUGHTON,  
E. S. W. FARNUM, JR.,  
HUGH M. MORRIS,  
*Counsel for Defendant Appellant.*

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ORDER.  
(Filed Apr. 19, 1937.)

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And Now, To-Wit, this 19th day of April, A. D. 1937, the attached stipulation of counsel for the respective parties in the above-entitled cause having been presented to and maturely considered by the Court,

It Is Ordered By The Court as follows:

1. That the statement of testimony and evidence taken upon the trial of said cause, in the condensed narrative form attached to said stipulation, be and the same hereby is approved and said narrative statement shall be filed in the Clerk's office and become a part of the record for the purpose of both appeals.

2. That but one transcript of record on the appeal taken by the plaintiffs in said cause and the appeal taken by the defendant in said cause shall be certified to the United States Circuit Court of Appeals for the Third Circuit.

3. That pursuant to order of said United States Circuit Court of Appeals for the Third Circuit, the exhibits in said cause, susceptible of reproduction, shall be omitted from the printed record on said appeals and said exhibits shall be submitted on said appeals

as physical exhibits in the form of five bound copies of reproductions thereof.

W. H. KIRKPATRICK,

*J.*

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### OPINION

SUR PLEADINGS AND PROOFS.

(Filed October 5th, 1936.)

Before KIRKPATRICK, *J.*

SUR PLEADINGS AND PROOFS.

This is a suit in equity for the infringement of six patents, Nos. 1,584,149; 1,584,150; 1,584,151; 1,584,152; 1,584,479 and 1,896,020, all of which have to do with the production of fine powder of lead by the abrasion of larger pieces of metallic lead in a dry state. Various claims of the six patents cover process, product and apparatus. The claims in suit are, 1 and 2 of 1,584,149; 1-4, 6, 8-17 of 1,584,150; 1-5 of 1,584,151; all claims of 1,584,152; 1-4 of 1,584,479; and 10 and 11 of 1,896,020.

The product is used in the manufacture of plates for storage batteries. These plates consist of thin grids upon which lead paste is spread. The base of the paste is the powder, to which are added certain ingredients with which we are not concerned. It has been the experience of the industry that unless the powder is exceedingly fine and uniform in texture the paste will crack, peel or flake off from the grids when the battery is in use and thus shorten its life and impair its efficiency. The powder consists chemically of lead of which the greater part has undergone some degree of oxidation. The precise proportion in which pure lead and lead oxides appear in the mixture as well as the degree of oxidation are not important except as they effect its physical properties.

Until fifteen or twenty years ago, makers of storage batteries bought their powder. It was manufactured by various molten lead processes and consisted of finely divided litharge, red lead or other of the higher oxides. It was far from satisfactory, lacking the requisite uniformity and fineness. The necessity of purchasing it from others added to manufacturing costs. These drawbacks combined to make the matter of obtaining the powder a major problem in the industry. It can readily be seen that the development of a process by which makers of storage batteries could, without prohibitive expense of installation, produce in their own plants and in commercial quantities a thoroughly satisfactory powder would be of immense advantage to the industry, and it is not surprising that manufacturers in various parts of the world were spending a good deal of time and effort toward this end.

#### HISTORY OF THE INVENTION.

A brief account of the development of the process involved in this suit will be useful, not only in fixing the date of invention but also as a means of getting an understanding of its nature and the importance of its various elements:

Beginning about the middle of September, 1918, the plaintiff, Genzo Shimadzu, the largest manufacturer of storage batteries in Japan, and the head of many other industries, started experimenting with the idea that pieces of lead or lead balls could be abraded into powder by tumbling them together in a revolving vessel. He tried out, successively, porcelain vessels borrowed from the pottery industry, wooden drums, with and without metallic linings, vertical grinders of the mortar type, and a large specially constructed iron drum. He made a great number of trials during



September, October and November of 1918. Most of the product obtained was too coarse and irregular to be of any use; though some small amount of "hopeful fine powder" was observed. He also tried separating the fine from the coarse after the product had left the mill, by means of an air blast—which worked well enough but left the residue of coarse powder as pure waste.

Finally in December, 1918, he hit upon the idea of directing an air blast directly into the vessel in which the lead was being abraded, and a large metal drum was constructed with an inlet for the air current and an outlet by which the fine powder could be blown out. After some experimentation the inlet was fitted with a tube extending into the drum, having nozzles so that the air could be blown directly upon the abrading masses. This apparatus was completed and first operated in March, 1919.

It was at once observed that the amount of the product increased tremendously. This was a development of the greatest importance. The mere knowledge of some process by which the right kind of powder could be produced in trifling amounts was of very little value to anyone. The industry was looking for a way to make large quantities cheaply, and an invention which fell short of accomplishing that result would have been of academic interest only.

The increase in production was due to the fact that the air was an oxidizing agent, forming a brittle layer of oxidized lead upon the plastic surfaces of the balls, which easily abraded off leaving a fresh surface, upon which the process was continued until the balls were entirely pulverized.

It is possible that at that stage the plaintiff had no real appreciation of the importance of the oxidizing effect of the air current. He appears to have



thought that the removal of the dust was the principal cause of the increase in production. There was some ground for this belief, since it was not unreasonable to think that as long as the dust remained in the drum it would act more or less as a lubricant for the surfaces of the balls. But certainly, with the scientific resources and expert assistance at his command, he must have known that oxidation would be accelerated by the introduction of the air current. How much more than that he knew is hard to say.

Full commercial realization of the process did not follow immediately upon the installation of the mill in Shimadzu's plant (which was in June, 1919). That came only after more experimenting. Although some mechanical improvements upon the apparatus were made, most of this work had to do with the speed of revolution of the mill and the force and volume of the air current. What was actually being worked out, whether consciously or otherwise, was a second and highly important element of the process, namely, temperature control. Production in satisfactory quantities depended upon abrading the balls to powder as rapidly as possible and that in turn depended upon determining and maintaining a temperature in the mill which would be high enough to produce rapid oxidation but not so high as to melt the metal or to over-oxidize the product. The mill was large enough to be used commercially, and the plaintiff's witnesses referred to this period as "industrial scale experimental research". It was carried on from June, 1919, through the spring of 1920. Long before its termination, successful operation was so assured that it was decided to build a plant solely for the production of powder by the new process. The construction of the new plant was started in April, 1920, was completed in June of the same year, and went into regular operation about that time.

I fix the date of invention and successful reduction to practice as not later than August, 1919, that being the date of the "powdering machine" having the construction shown in Figure 28 of Ishimura's notebook. Whether or not the plaintiff, even then, fully realized the chemical reaction which made his process a success is beside the point. He certainly knew by that time that, subject to working out of details, he would be able to obtain large quantities of a satisfactory product. That was his major interest as well as that of the industry. A research scientist would, undoubtedly, have centered his attention upon the chemical reaction involved, but Shimadzu was a practical commercial operator, and I think it clear that he had enough appreciation of what was necessary to obtain the desired result for me to fix the date of invention at or before the time referred to, which is all that is necessary for the purposes of this case.

The process was unquestionably invented when the idea of blowing an air blast into a rotating mill in which lead pieces were being abraded and keeping the whole at a controlled high temperature by means of regulating speed of revolution and air pressure had been evolved and successfully practised, and this point had been reached well with the time fixed.

The Process Claims of the Patents, Particularly 150.

At this point it will be convenient to summarize the process claims of the American patents postponing discussion of the product claims until later.

The important patent is 1,584,150. Some of the process claims of this patent define the thing which the process produces as "a fine powder of lead suboxide intermingled with powdered metallic lead (claims 1, 2, 3, 4, 6 and 8). The remainder define it as a finely divided powder containing a large proportion of oxidized

lead without any mention of lead suboxide, (claims 9, 10, 11, 12 and 13). Claim 7 is not in suit. Passing over the first group ("suboxide" process claims) for the present, claim 9 is typical of the second group. It calls for the following steps:

1. Impinging a current of air on lead masses in a dry state;
2. Abrading the lead masses;
3. Controlling the temperature to obtain a finely divided powder containing a large proportion of oxidized lead.

Claims 10 and 13 fix the necessary temperature at above 60 degrees centigrade.

Claim 2 of '149 is another process claim of this type, referring to "a finely divided chemically reactive lead powder of such fineness and activity as to be readily changed chemically on exposure to air". The air current is introduced into the vessel for the purpose of removing the powder formed by attrition of the lead masses. This patent contains no suggestion of the oxidizing effect of the air, or of temperature control.

The '151 patent carries on the process of '150, and deals with the further oxidation of its product to form higher oxides such as litharge and red lead. This patent really belongs with the product claims, since its process begins with a lead suboxide powder. It stands or falls with the product claims of '150.

'152 has to do with paint and depends on the product claims of '150 rather than the process.

'479 relates to the preparation of the plates for storage batteries, mixing the product obtained by the earlier patents with various liquids.

The '020 patent is for the apparatus.

In all the process claims of '150 in suit the essence of the invention claimed is accelerated abrasion by oxidation of lead surfaces by air blast and regulated temperature.

#### THE JAPANESE PATENTS.

In November of 1920, the plaintiff applied in Japan for a patent which was later issued to him as Patent No. 42,563. Both before and after that time he also applied for other Japanese patents, but '563 is the only one which need be considered in this connection. The application date was more than a year before the plaintiff filed his application for U. S. '150 or, for that matter, for any of his American patents, and therefore R. S. 4887 would invalidate the American patents if the latter are for the same invention.

The law, as laid down by the Circuit Court of Appeals for the Third Circuit in *Altoona Publix Theatres vs. American Tri-Ergon Corporation*, 72 Fed. (2d) 53, is that where the defense is in invalidity under R. S. 4887, the question is not what was disclosed, but what was claimed in the earlier patent. The language of the statute makes it clear that it is the patenting of the invention which is material, and it is the claim, not the disclosure of the specification, which determines what has been patented. In the opinion referred to, the Court said, "There are many features disclosed in the German Patent which are not claimed, and in law the patent stands as though the features were not disclosed." The foreign patents and the American must be identical (*Leeds & Catlin vs. Victor Talking Machine Company*, 213 U. S. 301) and a heavy burden of proof rests upon the defendant to show that they are. *General Electric Company vs. Alexander*, 280 Fed. 852.

Claim 1 of the Japanese Patent, No. 42,563, is as follows:

"In order to achieve the object recorded earlier in this record, a method of manufacturing chemically reactive lead powder is claimed, a special feature of which is throwing lumps of lead into a rotating vessel, and blowing currents of air or other inactive gases into the vessel during rotation to force the small particles produced by rubbing out of the vessel."

The other claims are like enough to the first to require no separate discussion.

Is this a claim for the invention patented in U. S. 150? I do not think that it is, and when the whole disclosure of the Japanese patent is read carefully that conclusion is fortified. The first thing that strikes one is that there is not the slightest suggestion of any oxidizing effect of the current of gas which is introduced into the mill. On the contrary, it would seem that there was a definite purpose to avoid oxidation. The patent has to do with the purely mechanical step of removing the lead powder from the rotating vessel. It almost looks as though the patentee feared that, in the course of removal, oxidation would take place and provided, according to his lights, against it. For example, he points out that powder produced by the process of an earlier patent (which provided no means for its removal) is likely to ignite spontaneously, due to the heat of friction inside the mill. "But this defect he says "is . . . eliminated by the present invention, by blowing in air or some other inactive gas with a resultant cooling effect." Obviously, the teaching of the patent is that the mill should be operated at as low a temperature as possible.

The cooling and conveying medium is described in all the claims as "air or other inactive gases". This is a flat contradiction in terms. An inactive gas is one which has no oxidizing effect on other substances. Air, containing about 21% oxygen, is an active gas.

It is certainly an extraordinary thing that the plaintiff should have been unaware of this but, nevertheless, the use of the word "other", read in the light of the object of the patent as disclosed in the entire specification, leaves no doubt that he mentioned air as an example of a convenient inactive gas. The best guess that one can make of what he had in mind was, that he meant to patent a process for mechanically removing fine powder from the drum by means of a current of some non-oxidizing medium, and that he believed that air with its high percentage (78%) of nitrogen, if delivered at a low temperature, would be sufficiently inert to serve his purpose and prevent combustion within the drum. It is scarcely necessary to point out how completely this misses the invention described in the American patent, which depends primarily upon the initial and continuous rapid oxidation of the surfaces of the metallic lead, accomplished by the air blast, the regulation of the heat and of the amount of oxidizing gas all being directed to obtain this reaction to the maximum effective degree.

Besides this, if the Japanese patent has been correctly interpreted as a disclosure of the use of a non-oxidizing medium, it is invalid, regardless of what it attempts to claim, because the process is perfectly useless and inoperative. It was demonstrated conclusively both by witnesses at this trial and by Ishimura in the course of his efforts to develop the process, that, if lead balls are tumbled together in an inert atmosphere, the result will be nil. The balls will simply polish one another and not an ounce of powder will result.

But the defendant argues that, even if the claims do not cover the American patent and R. S. 4887 does not apply, the unclaimed disclosure of the use of an air blast upon the abrading lead masses was dedicated



to the public or anticipates as a foreign publication. In order to get even a starting point for this argument it is necessary to omit the word "other" wherever it occurs in the phrase "air or other inactive gas". If this is done (and I do not see how it can be) the best case that can be made out for the defendant's theory is that the disclosure suggests two inconsistent, and mutually exclusive methods, one of which may lead to a useful result if understood and further developed by temperature control, and the other of which leads to nothing. A disclosure of this kind cannot operate either as an anticipation or as a dedication of anything to the public. A patent, like any other instrument, may be of doubtful meaning or it may contain several meanings applicable to varying conditions but it cannot have two meanings inconsistent with each other. See *Kintner vs. Atlantic Communication Company*, 240 Fed. 716, 720. "A document so obscure in its terminology that two conflicting theories may be deduced therefrom and supported by equally plausible arguments is too indefinite to be utilized as an anticipation." *Cimiotti Unhairing Company vs. Comstock Unhairing Company*, 115 Fed. 524.

If this patent (amended to suit the defendant's argument by striking out the word "other") were placed in the hands of a person skilled in the art, with instructions to inaugurate the process, he could but guess as to which method to use. As a matter of fact, he would be more than likely to confine himself to nitrogen or some inert gas, because the patent seems to imply that an active gas might be detrimental; and he might spend an indefinite period of experimentation and even have to exercise truly inventive qualities before he ever reached the point of using an oxidizing medium.

But the foregoing discussion is perhaps unneces-



sary. The patent cannot be read as a disclosure of alternative processes. It must be interpreted with a certain amount of common sense and regard for its plain objects. The last thing it intended to teach was the use of an oxidizing agent. When air was referred to, it was as an example of a non-oxidizing gas, and to say that this incidental and erroneous use of it amounts to a disclosure or dedication of something which the patent obviously meant to steer clear of is going very far out of the way to destroy the American patent.

For whatever it may be worth, it is pretty clear that the plaintiff himself did not understand that, when he applied for Japanese '563, he was taking out a patent on the same process which appears in U. S. '150, because subsequently, in Japan, he took another patent, No. 60,825, which corresponds very closely with U. S. '150, and, being within the year, does not invalidate it. We are not concerned with the motives which prompted him, in taking out the '563 patent, to confine it to the single step of mechanical removal of the dust from the drum, and to withhold the really essential steps of the invention for later patenting. It is sufficient to say that he had the right to do this if he chose.

#### ALLEGED PRIOR PUBLIC USE.

The Activities of the Defendant and the Tudor Mill.

Since about 1900, the defendant has been engaged in manufacturing storage batteries in the United States. It originally bought its lead powder and was having the same difficulties keeping up the quality of its battery plates and in reducing production costs as the plaintiff found in Japan. Like the plaintiff, it was looking about for some way of manufacturing its own lead powder and improving it in order to meet the exacting requirements of its trade. At an early

date it had imported some red dust from A. F. A., a large storage battery manufacturer in Germany, with whom it had an arrangement for exchange of technical and engineering information.

In 1907, one of the defendant's engineers observed the operation of an apparatus known as a Tudor mill in the German plant, and brought back a report about it. In 1912 he again visited and again reported. Finally, in July, 1915, the defendant bought a Tudor mill duplicating those seen by their engineer in Germany and set it up in its plant, putting it into operation about the middle of 1916. The engineer who had been in Germany turned over to the official in charge of the mill all the information which he had obtained about it. Various runs were made for the purpose of obtaining a product and in 1917 and 1918 batteries constructed from the powder were sold to New York Railways Company. The first order was for 70 sets of batteries at a price of \$65,000 comprising some 16,000 plates. A second order was for about a fifth of that amount.

About the middle of 1918 however, the mill was dismantled (the plaintiff says "junked.") and sent out to the Willard Storage Battery Company in Cleveland—a concern controlled by the defendant. It was not operated at the Willard plant until May, 1920, but shortly after that date some runs were made and a comparatively small quantity of lead powder was produced which was used in regular production of plates. Then the mill was dismantled again and shipped back to the defendant in Philadelphia where it was stored until it was finally disposed of as scrap metal.

While it is true that the orders of the New York Railways Company were not repeated and that the commercial production at the Willard Company was unimportant, and while there was undoubtedly a great

deal of experimental work being done with the mill all through these operations, I cannot agree with the plaintiff that the whole incident must be dismissed as an abandoned experiment. Certainly it was not a great success, as can be seen from the bare recital of the facts about it. There is nothing to indicate that the product was not satisfactory, but the mill never produced powder in sufficient quantity to justify its continuation in commercial use. Nevertheless, I think it might stand as a prior public use against the plaintiff's patents, provided it really anticipated the plaintiff's invention—a question which will be considered later.

In July, 1920, the defendant set about installing a full-sized plant for the manufacture of lead powder at Philadelphia. Mr. Hall was engaged for that purpose. No powder had been produced at the Philadelphia plant since 1918. Hall had complete plans of the German Tudor mill together with engineer's reports and notes and the records of its operation in Philadelphia, but attempted no further development along that line. Instead, he decided upon what he referred to as a "radical change" from the German mill. As a matter of fact, he discarded it altogether and proceeded to install an entirely different type, which embodied the plaintiff's principles and in which the principal element was a Hardinge conical mill. He "recognized that means must be provided for admitting air into the interior of the mill" and proceeded to do so. He also, by this time, understood that temperature control was an important part of the process if quantity production was to be obtained. The defendant's engineer testified "As the mechanical equipment of this installation was perfected, it developed that a Hardinge mill made possible a very wide and different control of product. The primary element entering into

the control proved to be: Amount of air admitted to mill. Temperature of the interior of the mill. Lead within the mill. . . . It became evident at once the Hardinge mill was started that a different flow of air through the mill must be provided . . .". To "standardize" the quality a great deal of experimenting by the research department was required, which continued after the mill was set up. Referring to the date of June, 1921, the witness testified "As the main principles of operation were now understood . . .". The mill was installed early in 1921 and was not in commercial production until some time after April 22 of that year.

In 1923 the present plant was erected and four Hardinge mills installed and in July of that year large scale commercial production continued. Commercial production by the Hardinge mill with its forced air draft undoubtedly involved the use of the plaintiff's patent, and June, 1921, may be fixed as the date when that began.

To return to the Tudor mill. Regardless of the lack of commercial success with this, I am of the opinion that it cannot be considered as a prior public use against the patents in suit, because its entire operation failed even to approximate the essential idea of the plaintiff's process patent. If it is a mere question of a literal reading of the patent, it may be possible to find in the Tudor mill process the bare elements of the plaintiff's patent, but if the method of operation be carefully considered it will be seen how far away from the spirit it is. The essence of the plaintiff's patent, as has been already seen, is forcing a continuous blast of air into the drum at a controlled high temperature so that oxygen will be absorbed by the lead and form a brittle oxidized surface which could be rapidly abraded off. Now, in the Tudor mill, the

whole surface of the drum was perforated with a great number of eighth inch holes. The drum was surrounded by a fine mesh cylindrical screen and this in turn by an outside iron casing. A certain amount of air of course got into the drum through the casing, and a moderate draft was established, apparently to prevent it getting too hot, by putting a stack at the top of the casing and a small vent pipe with a damper at the bottom. That was all. There was absolutely no suggestion or thought of blowing or forcing the air into the drum. As a matter of fact, the broken and powdered material lying against the perforations in it must have kept a great deal of the circulating air out. The defendant never had the slightest conception of the effect which even this gentle circulation of air had upon the lead surfaces to be abraded. The correlation between oxidation in the drum and increased yield was not perceived. Its engineer considered that the only really important oxidation that took place in the lead powder was after it left the drum and as it descended by gravity in the casing into the kegs to be filled. Naturally, there was no thought of temperature control to get the maximum degree of oxidation in the drum. The results were about what would be expected. The amount of product obtained was very limited and the mill simply did not solve the problem or meet the requirements of a commercially useful process. It was abandoned.

Both the plaintiff and the defendant had been confronted by the same industrial difficulties. Both were groping for a way of overcoming them and both reached a satisfactory result. There is no evidence—nothing more than a suspicion—that the defendant's abandonment of the Tudor mill and its adoption of the process of the plaintiff was caused by anything learned at the plaintiff's mill in Japan. It does not

detract from the quality of the invention that it was reached independently by another in a distant part of the world. On the contrary, the fact that different streams of inventive effort had for years been directed toward the same end, goes to show the importance of a successful outcome to the industry.

#### THE HALL-SHIMADZU INTERFERENCE.

In 1924 Mr. Hall filed an application covering the process which had been developed in the defendant's plant. The plaintiff's applications for his American patents had been filed during the years 1922-1924. While the Hall application was pending, Shimadzu's patent '150 issued. Hall believed the processes of the two applications to be identical, added claims 2, 3, 4, 6, 14, 15, 16 and 17 of Shimadzu to his application, and interference was declared. The Law Examiner held that claims 9 to 13 Shimadzu (process claims not referring to lead suboxide) were unpatentable. As to the other claims, the Board of Appeals for the Patent Office awarded priority to Shimadzu, and this decision was affirmed by the Court of Customs and Patent Appeals.

I do not think that this phase of the case deserves quite the importance which the parties have given it, or that it is necessary to go in detail into the testimony before the tribunals of the Patent Office, or into the reasons for its decision stated by the Court of Customs and Patent Appeals. The sole issue determined, and the only point as to which those proceedings are res judicata, is that, whatever Hall may have done, he had not made the invention of Shimadzu's '150 patent prior to the time when Shimadzu made it. Upon this issue the burden lay upon Hall to establish that he was the prior inventor, and this burden the Court held that he did not sustain. It was the only



question which the tribunals of the Patent Office had jurisdiction to decide. The interference proceeding and this infringement suit are not based upon the same cause of action, and in such case the law is well settled that only those questions actually decided in an earlier suit are *res judicata* in a later one. *Troxell vs. Delaware, Lackawanna & Western Railroad Company*, 227 U. S. 434.

The record in the interference was relevant only as it affected the value of the testimony given by the witnesses who testified in both cases. In the earlier proceeding Hall had asserted that his process was capable of producing, and did produce, the product of Shimadzu's '150. Ishimura, who had not seen it in operation, but who had painstakingly set up a duplicate mill, had testified that it could not possibly do so. Both witnesses, when called in the present case, were compelled to explain a number of embarrassing inconsistencies—an ordeal which, I think, both went through as gracefully as possible under the circumstances. Otherwise, the interference proceedings do not require extended consideration.

#### PRIOR ART PATENTS.

The defendant has cited a number of prior patents against the patents in suit, with particular reference to '149 and '150.

The plaintiff is undoubtedly entitled to rely for priority upon the date of invention and reduction to practice as found, regardless of the fact that the invention was made in a foreign country. *Claude Neon Lights, Inc. vs. Rainbow Light, Inc.*, 47 Fed. (2d) 345. *Hanover vs. E. H. Godshalk Company*, 78 Fed. 811. This eliminates from consideration the Belgian Tudor Patent, No. 239,406, Thibault French Patent, No. 494,270 of September 4, 1919, and one of two others.



Of those remaining, only Bailey U. S. Patent, No. 846,384, requires extended consideration. The Thibault patent, *supra*, will however be discussed because its date is so very close to the date of invention.

As to these patents, as well as all the others cited by the defendant, the general observation may be made that in a great industry, with unlimited capital and expert knowledge of the highest type at its command, endeavoring for many years to reach a solution of a serious problem, they made not the slightest impression. To draw the conclusion from this that they were wholly inoperative would be perhaps going too far. But, whatever the reason, it can be safely said that they somehow missed the mark—a fact which must be borne in mind when their disclosures are considered as prior art.

In Bailey's patent, a cylinder is equipped with mechanical beaters or paddles and into it is fed lead already in a rather fine state of division. It is stated in the specification that molten metal may be first blown by air or steam to a suitable degree of fineness. The device is clearly intended to begin its operation upon lead already in the form of a powder. Certainly the exemplification of the apparatus given in the specification would not work upon any other type of material. The beaters reduce the coarse powder to a finer state and a current of air is used to remove the fine product after it is produced. No doubt oxidation takes place in the course of the procedure, and the final product may well be very similar to that of the plaintiff's patent.

But there is no suggestion whatever of the oxidation of the lead masses to produce a large quantity of product by their rapid and complete abrasion acting upon themselves, and without other mechanical means. Bailey's final product is only in a very remote degree

the product of abrasion. True, he throws in the suggestion that "... it is possible that the product may be produced in many ways, as by a grinding or abrading process," but this casual reference is too indefinite to amount to an effective disclosure. It may, and probably does, mean preparing the metallic lead for the mill by the use of grinding stones, filing machines or other abrasive devices. If it is intended as an alternative to the entire process, then it contains no suggestion of the air blast. At all events, it is entirely too indefinite to amount to an anticipatory disclosure of the vital principle on which the plaintiff's process is based. From the fact that the air is introduced halfway up the cylinder, and sucked out at the top, it looks as though Bailey felt it undesirable that the air should do anything other than carry out the fine dust. The abrasion which would take place among the grains of coarse powder as they were agitated by the beaters would be entirely negligible in obtaining the quantity production which is, after all, the object of all these processes.

Thibault puts his material into a cylindrical vessel and simply cooks it—an operation which he assists by blowing compressed air and steam into the vessel, which might well be called a kiln. It is a closed vessel and the combined steam and air pressure is regulated by a needle valve. Again, the material preferred is lead in granulated form, which suggests preliminary treatment of some kind to reduce it to a suitable degree of fineness. Some fine particles escape through the valves and are collected, but the bulk of his final product is what remains in the vessel after the process of oxidation is completed.

The vessel may be, but does not have to be rotatable. It would not be too much to say that Thibault not only fails to utilize abrasion of the oxidized

masses in order to get a mixture of lead and an oxide of lead but rather definitely excludes it. The complete oxidation of his material was the thing that he was primarily trying to obtain. Any metallic lead in the final product was plainly an undesirable by-product. As in Bailey, the basic principle of the plaintiff's patents is ignored. Finally (a matter of immense practical importance) the process cannot be carried on continuously, since at the end of a seven or eight hour period, the entire charge of metallic lead has been converted into oxide, and the mill must be stopped and cooled and the charge removed before it can be reloaded. This fact alone, necessarily reducing the production to a small fraction of that which can be obtained from the plaintiff's process, would put the device out of the field as an anticipation of the plaintiff, and possibly accounts for its failure to make any impression.

#### THE PRODUCT CLAIMS.

Claims 14, 15, 16 and 17 of '150, and claims 1 and 2 of '152 are for the product. They all describe the powder as composed in part of lead suboxide. Claim 17 of '150 may be taken as typical. It is:

"As a new composition of matter, a highly chemically reactive powder, comprising a large portion of lead suboxide, said powder being capable of spontaneous reaction on contact with air."

With regard to these claims the defendant's position is that lead suboxide is a purely hypothetical substance which has no actual existence, and that, therefore, the claims are invalid or if valid are not susceptible of being infringed.

Lead suboxide, according to the plaintiff's theory, is a chemical combination, the molecular structure of which is two atoms of lead combined with one of oxygen. Its symbol is  $Pb_2O$ .

Quite a number of higher oxides of lead have been identified, and are now well known to science. The existence of  $Pb_2O$ , however, is not, at the present time, accepted as a scientific fact. There are eminent authorities who affirm it, and others, equally worthy of acceptance, who deny it. The entire matter may be said to lie in the realm of controversy.

The plaintiff concedes that the substance is of a fugitive character, rapidly transformed into a higher oxide in the atmosphere, difficult to segregate, and not susceptible of identification by an ordinary method of chemical analysis. Within the last quarter century, however, there has been developed a method of analysis by use of the X-Ray grounded upon the basic crystalline structure of certain substances, various forms of crystals being represented by certain arrangements of imaginary points and lines known as space lattices and the structure of the substance under examination being identified by referring its X-Ray spectrum or diffraction pattern to calculated patterns of the space lattices. Using this method as his principal support, the plaintiff's expert testified to the existence of the lead suboxide as a chemical compound, and to its presence in the product of the defendant's mill. Using the same method, the defendant's experts reached a diametrically opposite conclusion.

Upon this issue thus presented, a very large amount of extraordinarily interesting testimony was taken. I shall not attempt to do more than briefly comment upon it, and state my conclusion.

Berzelius, about a century ago, prepared a black powder containing lead by igniting lead oxalate in a vacuum. This product was highly reactive and took fire spontaneously in the air. Having analyzed it, he gave it the name lead suboxide, owing to the fact that

it contained less oxygen than lead monoxide, commonly known as litharge. For almost a century this substance has been described in textbooks and handbooks as lead suboxide. However, rather recently its existence came to be regarded with a certain amount of skepticism, a few chemists believing it to be merely a mixture of finely divided lead and lead monoxide.

I believe that the plaintiff concedes that the experiments of Berzelius could not have produced lead suboxide, in the proportion in which Berzelius believed that he found it, and, if at all, only in very minute quantities.

In 1926, Ferrari published the results of an X-Ray examination of a sample of so-called lead suboxide of Berzelius. He claimed to have found lines in the X-Ray spectrum of this substance which indicated the presence of  $Pb_2O$ . Subsequently, at least two other scientists repeated Ferrari's work and were unable to duplicate his results. Consequently, they drew the conclusion that Ferrari's original data were in error and that there was no evidence for the existence of lead suboxide in the black powder of Berzelius. Despite these publications questioning the validity of Ferrari's experimental work, there has come from his laboratory no additional paper containing evidence in confirmation of his original data.

Dr. Davey and Dr. Anderson, the experts for the defendant, both well known workers in this particular field, have examined by the X-Ray method of analysis samples of the defendant's product and have been unable to find any evidence for the existence of suboxide in either it or in samples of black oxide prepared according to the directions of Berzelius.

Dr. Clark, the plaintiff's expert in this case, an outstanding authority upon laboratory technique, examined similar samples of the defendant's product

and of the black oxide of Berzelius and testified that he found some lines which correspond very closely with Ferrari's pattern. He also by means of a super-centrifuge separated from the defendant's product some very finely divided material which he claimed to be nearly pure lead suboxide. In substantiation of this he made a chemical analysis of the product and states that the percentage of lead corresponds fairly well with that required by the formula of lead suboxide,  $Pb_2O$ .

Against these conclusions, it was pointed out by Dr. Davey with much force that, inasmuch as pure  $Pb_2O$  has never been segregated, there is no existing X-Ray pattern for it and that, consequently, the conclusions of Dr. Clark are only warranted if the calculated or hypothetical lattice for  $Pb_2O$  is actually the correct one. It is also true that the percentage of lead, as reported by Dr. Clark from his chemical analysis, while it happens to correspond to the theoretical demand of  $Pb_2O$ , does not by any means prove that  $Pb_2O$  is actually present, since the same percentage might be given by a mixture of lead and lead monoxide.

Without questioning either the accuracy of Dr. Clark's experimental data or the sincerity of his rather guarded conclusion, or that of the much more positive opinions of the defendant's experts, my verdict must be "not proven" as to either the existence or non-existence of the questioned substance. Such a verdict is, I believe, in accordance with the general position of scientific thought upon the question today. It would be little short of absurd for me to make a definite fact finding in a field in which science itself has arrived at no generally accepted conclusion, and I shall not attempt to do so.

This recalls us to the fact that we are engaged in



the determination of a dispute between two parties in a court of law, rather than in an excursion into the realm of scientific research, and we must approach the question from the standpoint of the rules which the law has established for resolving the controverted issue. The patent is by reason of its issue presumptively valid and the burden of proof is upon the defendant to show its invalidity. I am unable to find as a fact that lead suboxide does not exist. The burden has not been met, and the product claims are therefore held valid.

On the other hand, the burden is upon the plaintiff to prove infringement. He has not established the fact that suboxide is to be found in the defendant's product and so has failed to meet the burden. I therefore hold that the claims above referred to are not infringed.

#### THE "SUBOXIDE" PROCESS CLAIMS.

These are claims for the process, in which the product is incidentally described as containing lead suboxide. They are claims 1, 2, 3, 4, 5, 6 and 8 of '150, claim 1 of '149, the 7 claims of '151, and the 4 claims of '479. The considerations which apply to them are quite different from those which I have stated in connection with the product claims.

In these claims what was primarily intended to be covered was a method of producing in commercially useful quantities, a lead powder of such fineness and uniformity as to make it satisfactory for battery plates.

Undoubtedly, the adoption of the term, lead suboxide, by the plaintiff to describe one of the constituents of his product was due to the fact that under certain conditions it was of low oxidation and almost black in color. Anyone in his position in, let us say 1920, consulting a standard chemical dictionary would



probably feel justified in drawing the conclusion that he had in his product a large proportion of this black oxide of Berzelius. At least he would find numerous statements in textbooks justifying his use of that term. It might be pointed out in this connection that X-Ray analysis was not applied to an examination of the black oxide of Berzelius until eight years after Shimadzu undertook his first experiments.

Now it is well established that even in product claims an inventor is entitled to considerable latitude in his definitions, and may to a large extent define the product in his own terms. A fortiori, where the invention is for a process for obtaining a commercial product in which the physical rather than the chemical qualities are the important thing, he will not invalidate his patent because in naming the product he has adopted a term, well recognized by the scientific world, which later turns out to be of doubtful accuracy. The patent law is not concerned with abstract scientific principles, but with the means of usefully employing processes, apparatus, etc., which may result therefrom. As observed by Mr. Justice Holmes in *Minerals Separation vs. Magma Company*, 280 U. S. 400, 403, “. . . no one concerned in this business would care a straw as to the intimate nature of the action if it produced the result”.

From what has been said, it follows that, as to these process claims, infringement may be found if the process covered is used by the defendant, even though it is impossible to prove that the product manufactured by the defendant contained lead suboxide. Where the product claims are the only things in issue, suboxide is necessary to their validity over the prior art, since small quantities of a powder having generally similar physical characteristics had undoubtedly been produced before, and consequently infringement

cannot be found without proof that lead suboxide exists in the accused mixture. But where the question is the use of a commercial process to obtain a product in quantity and the description of the product is more or less incidental, it would be more than unfair to deny the inventor the rights to which he would be otherwise entitled because of a misdescription.

What has been said may be taken as applying to the suboxide process claims of '149 and '150. The five claims in suit of '151 and the four claims of '479 are process claims but they stand upon a slightly different basis. They begin with the product of '150 and treat it in order to produce something different. In every case this initial product or element of the process is described as being or containing lead suboxide. Now, as has been held, it will not necessarily invalidate a process that its final product is given a name which is scientifically incorrect. But in these claims the use of the described powder is the first and vital step of the process. It is the suboxide constituent which gives them novelty over the prior art. Therefore they really stand with the product claims—presumptively valid but in the present state of scientific knowledge not susceptible of proof of infringement.

#### PATENT '149 AND DOUBLE PATENTING.

Patent '149 claims a process for the formation of lead powder by abrasion of masses in a rotating vessel plus "removing said powder from said vessel by means of" a current of air (claim 2). This patent is not invalidated by Japanese patent '563 for reasons already given in connection with that patent. The erroneous use in the Japanese patent of air as an example of an inert gas is not sufficient to make it identical with a patent which claims the use of air and nothing else.

Whether or not '149 is for the same process as U. S. patent '150 is immaterial, so far as the question of validity of either is concerned. There is no double patenting involved. The two patents issued on the same day. They both expire on the same day. There can be no extension of the monopoly and one is not prior art against the other.

The fact that '149 does not disclose the oxidizing function of the air or refer to the highly important element of the process having to do with the temperature control necessary to its successful operation might throw doubt upon its validity in view of the prior art. This is, of course, upon the assumption that it is not for the same invention as '150. The whole matter however is rather academic since '149 is coincident in duration with '150, and the defendant's process infringes the somewhat more precise, if not narrower, claims of '150.

This patent is therefore held valid and infringed.

#### INFRINGEMENT OF PROCESS.

There can be no question that the process used by the defendant is substantially the same as that of the plaintiff's patents. In fact it is almost identical. As a fact finding upon this point the report of Dr. Wilson, an independent expert appointed by the Court who made a complete study of the defendant's operation at the Crescentville plant, is adopted by reference.

#### APPARATUS.

The apparatus patent (020) is closely related, of course, to the process patents. Practically all the considerations which apply to the one apply to the other, including the Tidor mill and other alleged prior art structures. Having held the process claims valid and

infringed, the same conclusion is reached with regard to the apparatus patent.

#### CONCLUSIONS.

Claims 1 and 2 of patent 1,584,149 are valid and infringed.

Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of patent 1,584,150 are valid and infringed.

Claims 14, 15, 16 and 17 of 1,584,150 are valid but not infringed.

Claims 1, 2, 3, 4 and 5 of 1,584,151 are valid but not infringed.

Claims 1 and 2 of patent 1,584,152 are valid but not infringed.

Claims 1, 2, 3 and 4 of 1,584,479 are valid but not infringed.

Claims 10 and 11 of patent 1,896,020 are valid and infringed.

The statements of fact contained in the foregoing opinion may be taken as special findings of fact and the statements of law may be taken as conclusions of law under Rule 70½.

Decree may be submitted.

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#### MEMORANDUM AMENDING OPINION AFTER REHEARING.

(Filed Nov. 20, 1936.)

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Before KIRKPATRICK, J.

The plaintiff has presented a petition for a rehearing requesting that the Court reconsider two statements or findings of fact, appearing in the opinion. These statements relate to the time when the defend-

ant began to use the process of the plaintiff's patent. That use began some time after the installation by the defendant of a Hardinge mill in its plant.

The statements referred to are the following:

1. "The mill was installed early in 1921 and was in commercial production during the entire year. especially the latter part."

2. "Production by the Hardinge mill with its forced air draft undoubtedly involved the use of the process of the plaintiff's patent, and January, 1921, may be fixed as the date when that began."

As to the first of these, the statement that the mill was in commercial production during the entire year is obviously wrong. It was shipped from New York on January 7 and could hardly have been set up and started before the middle of the month at the earliest. There is no evidence of anything approaching commercial production earlier than April 22. Smith's testimony was that "as soon as the Hardinge mill started to produce lead dust in quantity, this material was made into plates, which were then tested by the laboratories". The earliest written evidence relating to the plates was Exhibit 68 dated April 22, 1921, instructing the Superintendent's department to make certain plates for testing. On Smith's testimony therefore production "in quantity" could have begun about that time, but not substantially earlier.

I shall therefore eliminate the first statement above referred to and change the sentence to read "The mill was installed early in 1921 and was not in commercial production until some time after April 22 of that year".

As to the second statement of fact, it may be said at once that it was never intended by the Court to make

a finding of a prior public use (in the statutory sense of that term) by the defendant in January, 1921. Indeed, it is really very doubtful whether the defendant was using the plaintiff's process at all in that month. When the mill started, which as has been seen could not have been earlier than the middle of the month, there was no provision for any air blast. The only testimony as to when such provision was added is that of the defendant's witness who said "It became evident at once the Hardinge mill was started, that a definite flow of air through the mill must be provided and for this purpose a small blower, that happened to be on hand, was installed". It might be inferred that the blower was installed soon after the mill was started, but there is nothing whatever to show how soon. It might have been a day, a week or a month. The blower proved insufficient and a new blower was purchased on May 5. If the insufficiency of the small blower was such that it would be evident shortly after its installation, then it might be argued with much force that it had not been in use very long before May 5.

At any rate, the most cursory reading of the testimony of the defendant's witness Smith will show beyond question that for a very considerable time after the installation of the Hardinge mill, and possibly even after the addition of an adequate air blast in May, the defendant's operations were tentative and experimental. For example Smith testified that between March 21 and September 21 the engineer "had acquired the necessary skill to operate his mill" so far as the matter of temperature was concerned, and that "by the middle of 1921 he had got most of his mechanical difficulties straightened out and from that time was able to produce material satisfactorily". The witness Hall testified that for some four or five months after he started the mill (which would cover the time,



say, up to the middle of June) he was experimenting with a low oxide product which was never used commercially.

It is therefore plain that there is no evidence of anything beyond an experimental use by the defendant earlier than about the middle of the year 1921. It is entirely possible that the word "January" in the second statement of fact referred to above is a mere typographical error and that what the Court had in mind was, "June". However that may be and in order to avoid any possible misunderstanding as to the scope of the finding, I will amend it to read "Commercial production by the Hardinge mill with its forced air draft undoubtedly involved the use of the plaintiff's patent, and June, 1921, may be fixed as the date when that began".

The whole question has been thoroughly argued by counsel on both sides and it will not be necessary to take further testimony or to hear further argument. The rehearing is granted. Argument upon the presentation of the petition may be taken as having been made upon rehearing and the opinion will be amended in the two particulars referred to in the foregoing memorandum.

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DECREE.

(Filed Dec. 14, 1936.)

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This cause coming on to be heard at this Term of the Court, and upon the pleadings and proofs and argument presented by both parties, and the Court having filed its written opinion containing special findings of fact and conclusions of law, and upon consideration thereof, it is



Ordered, Adjudged and Decreed as follows:

1. That claims 1 and 2 of letters patent of the United States No. 1,584,149, granted to Genzo Shimadzu, dated May 11, 1926, being one of the letters patent in suit, are good and valid in law.

2. That claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, and 17 of letters patent of the United States No. 1,584,150, granted to Genzo Shimadzu, dated May 11, 1926, being one of the letters patent in suit, are good and valid in law.

3. That claims 1, 2, 3, 4, and 5 of letters patent of the United States No. 1,584,151, granted to Genzo Shimadzu, dated May 11, 1926, being one of the letters patent in suit, are good and valid in law.

4. That claims 1 and 2 of letters patent of the United States No. 1,584,152, granted to Genzo Shimadzu, dated May 11, 1926, being one of the letters patent in suit, are good and valid in law.

5. That claims 1, 2, 3, and 4 of letters patent of the United States No. 1,584,479, granted to Genzo Shimadzu, dated May 11, 1926, being one of the letters patent in suit, are good and valid in law.

6. That claims 10 and 11 of letters patent of the United States No. 1,896,020, granted to Genzo Shimadzu, dated January 31, 1933, being one of the letters patent in suit, are good and valid in law.

7. That the plaintiff, Genzo Shimadzu, now has and has had continuously since the issuance thereof title to each of the aforesaid letters patent of the United States, and Northeastern Engineering Corpo-

ration is and has been since the 14th day of February 1933, the exclusive licensee thereunder for the United States.

8. That the defendant, The Electric Storage Battery Company, has within six years prior to the filing of the Bill of Complaint herein infringed upon claims 1 and 2 of said United States letters patent No. 1,584,149, claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12, and 13 of said United States letters patent No. 1,584,150 and claims 10 and 11 of said United States letters patent No. 1,896,020, and has violated the exclusive rights of the plaintiffs thereunder by using and/or practicing the processes described and claimed in said claims of said letters patent 1,584,149 and 1,584,150 and by making and using the apparatus described and claimed in said claims 10 and 11 of letters patent No. 1,896,020.

9. That claims 14, 15, 16, and 17 of United States letters patent No. 1,584,150; claims 1, 2, 3, 4, and 5 of letters patent No. 1,584,151; claims 1 and 2 of letters patent No. 1,584,152; and claims 1, 2, 3, and 4 of letters patent No. 1,584,479 have not been proven to have been infringed by the defendant.

10. That a writ of injunction for the full term of the respective patents listed in this Paragraph, issue forthwith out of and under the seal of this court directed to the defendant, The Electric Storage Battery Company, enjoining and restraining the said defendant, and its officers, directors, associates, attorneys, clerks, servants, agents, workmen, employees and confederates, and each of them, from directly or indirectly using and/or practicing and/or threatening to use and/or practice the processes and methods described in said letters patent Nos. 1,584,149 and 1,584,

150, and claimed in claims 1 and 2 of letters patent No. 1,584,149 and 1, 2, 3, 4, 6, 8, 9, 10, 11, 12, and 13 of letters patent No. 1,584,150, and from directly or indirectly making, using and/or selling and/or causing to be manufactured, used and/or sold and/or threatening to manufacture, use and/or sell, apparatus containing or embodying the inventions of claims 10 and 11 of United States letters patent No. 1,896,020, and from in any wise infringing said letters patent and each of them and/or contributing to the infringement of said letters patent and each of them by others, and/or conspiring to so infringe said letters patent and each of them in any way whatsoever, and from directly or indirectly secreting, depleting, dissipating or in any manner disposing of the profits, gains and/or advantages which the defendant and its subsidiaries have derived from their infringement.

11. That the plaintiffs recover from the defendant and its said subsidiaries, the profits, gains and/or advantages which the said defendant and its said subsidiaries have received or which may have accrued to them by reason of their said infringement of said claims of said letters patent in suit, as well as the damages suffered by plaintiffs by reason of said infringement:

12. That this cause be referred to as Special Master of this Court, who is hereby appointed to ascertain, take, state and report to the Court the profits, gains and/or advantages made by the defendant, resulting from the use, practice and employment of the inventions of said claims of said United States Letters Patent Nos. 1,584,149, 1,584,150, and 1,896,020, and also the amount of lead oxide and lead powder made by said defendant by its mills, so held to infringe hereunder, by reason of its infringement of said letters patent throughout the period be-

ginning six years before the date of the filing of the Bill of Complaint herein, and the damages which the plaintiffs have suffered by reason of said infringement, and the plaintiffs on said accounting shall have the right to cause the examination of the officers, servants, agents and employees of the defendant, orally or otherwise, and also to examine other witnesses, and to cause the production and examination of the books, vouchers, records and documents of said defendant, and to have all necessary process of the court to compel such attendance and production before the said master.

13. That the plaintiffs recover from the said defendant the taxable costs and disbursements of the plaintiffs in this court, and that the plaintiffs shall have judgment and execution against the said defendant for said profits, damages and costs.

W. H. KIRKPATRICK,  
J.

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PETITION FOR APPEAL.  
(Filed Dec. 14, 1936.)

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*To the Honorable William H. Kirkpatrick, Judge of  
the District Court of the United States for the  
Eastern District of Pennsylvania:*

The Electric Storage Battery Company, your petitioner, who is the defendant in the above-captioned cause, prays that it may be permitted to take an appeal from the decree entered in the above cause on the 14th day of December, 1936, to the United States Circuit Court of Appeals for the Third Circuit, for the reasons specified in the assignment of errors which is filed herewith.

And your petitioner desires that said appeal shall operate as a supersedeas, and therefore prays that an order be made fixing the amount of security which said The Electric Storage Battery Company shall give and furnish upon such appeal, and that, upon its giving bond in an amount to be fixed by this court, the said appeal may operate as a supersedeas and may suspend, during pendency of said appeal, the effect of any injunction.

14 December 1936.

Philadelphia, Pennsylvania.

AUGUSTUS B. STOUGHTON,

E. S. W. FARNUM, JR.,

*Attorneys for Defendants.*

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ORDER ALLOWING APPEAL.

(Filed Dec. 14, 1936.)

The petition of The Electric Storage Battery Company, defendant in the above-entitled cause, for an appeal from the final decree, is hereby granted and the appeal is allowed; and upon petitioner filing a bond in the sum of Fifty Thousand Dollars (\$50,000.00) with sufficient sureties and conditioned as required by law, the same shall operate as a supersedeas of the decree made and entered in the above cause, and shall suspend and stay all further proceedings in this court including any injunction and until the termination of said appeal by the United States Circuit Court of Appeals for the Third Circuit.

14 December 1936.

Philadelphia, Pennsylvania.

W. H. KIRKPATRICK,

*District Judge.*

## ASSIGNMENTS OF ERROR.

(Filed Dec. 14, 1936.)

And Now, comes The Electric Storage Battery Company, defendant-below appellant, by Augustus B. Stoughton and E. S. W. Farnum, Jr., Esquires, its solicitors, and says that in the record of proceedings and in the decree in the above-stated cause, there is manifest error in the following, to wit:

(1) In holding and adjudging that Claims 1 and 2 of Patent No. 1,584,149 are severally valid.

(2) In not holding and adjudging Claims 1 and 2 of Patent No. 1,584,149 severally invalid under Revised Statute 4887.

(3) In not holding and adjudging Claim 1 of Patent No. 1,584,149 invalid under R. S. 4887 by reason of Japanese Patent No. 41,728.

(4) In not holding and adjudging Claim 2 of Patent No. 1,584,149 invalid under R. S. 4887 by reason of Japanese Patent No. 42,563.

(5) In not holding and adjudging Claims 1 and 2 of Patent No. 1,584,149 severally invalid by reason of the prior knowledge and of the prior use of the subject matter thereof by The Electric Storage Battery Company for more than two years prior to the application date for said patent.

(6) In not holding and adjudging Claims 1 and 2 of Patent No. 1,584,149 anticipated and severally invalid by reason of Belgium Patent No. 284,885 of February 4, 1920.



(7) In not holding and adjudging Claims 1 and 2 of Patent No. 1,584,149 severally invalid for want of invention in view of the state of the prior art.

(8) In holding and adjudging that the date of the alleged invention of Patent No. 1,584,149 was not later than August 1919.

(9) In holding and adjudging that the Claims of Japanese Patents No. 41,728 and No. 42,563 are not for the same alleged invention as claimed in Claims 1 and 2 respectively of Patent No. 1,584,149.

(10) In holding and adjudging that Claims 1 and 2 of Patent No. 1,584,149 have been infringed by The Electric Storage Battery Company.

(11) In holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally valid.

(12) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid under Revised Statute 4887.

(13) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid under R. S. 4887 by reason of Japanese Patent No. 42,563.

(14) In not holding that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid under R. S. 4886 in that the subject matter of Shimadzu's alleged invention was known by The Electric Storage Battery Company and others in this



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country before Shimadzu's alleged invention or discovery thereof.

(15) In not holding and adjudging that claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150, are severally invalid under R. S. 4887 by reason of public use in this country by The Electric Storage Battery Company for more than two years prior to the filing date of said patent in this country.

(16) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid by reason of United States Patent No. 1,584,149.

(17) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid by reason of R. S. 4888.

(18) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid under R. S. 4888 in that Patent No. 1,584,150 does not teach one skilled in the art how to produce lead oxide.

(19) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 are severally invalid for want of novelty and invention in view of the state of the prior art.

(20) In holding and adjudging that the date of the alleged invention of Patent No. 1,584,150 was not later than August, 1919.

(21) In holding and adjudging that claims of Japanese Patent No. 42,563 are not for the same

alleged invention as the process claims of Patent No. 1,584,150.

(22) In not holding and adjudging that Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Patent No. 1,584,150 have not been severally infringed by The Electric Storage Battery Company.

(23) In holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally valid.

(24) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally invalid.

(25) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally invalid in that said two claims were inserted in the application for said patent by amendment on June 4, 1932 after plaintiff had full knowledge of defendant's apparatus.

(26) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally invalid in that said claims were inserted by amendment in the renewed application for said patent on June 4, 1932, nearly four years after Hall Patent No. 1,675,345 had issued.

(27) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally invalid in that said claims were inserted in the renewed application on June 4, 1932, two years after one or more employees of The Electric Storage Battery Company, having knowledge of the latter's apparatus, had left the employ of The Electric Storage Battery Company without any pledge of secrecy.

(28) In not holding and adjudging Claims 10 and 11 of Patent No. 1,896,020 are severally invalid by reason of Japanese Patents No. 41,728 and No. 42,563.

(29) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are severally invalid in view of the two years' prior knowledge and use of the subject matter of these claims by The Electric Storage Battery Company.

(30) In not holding and adjudging that Claims 10 and 11 of Patent No. 1,896,020 are invalid because of the patentee's attempt to cover thereby the apparatus used by The Electric Storage Battery Company, of which the patentee had knowledge, for many years prior to the insertion of said claims in the application for said patent.

(31) In holding and adjudging that The Electric Storage Battery Company has infringed Claims 10 and 11 of Patent No. 1,896,020.

(32) In holding there was no suggestion or thought on the part of The Electric Storage Battery Company of blowing or forcing the air into the drum of its Tudor Mill.

(33) In holding and adjudging, as a matter of law, that plaintiff is entitled to rely for priority upon the date of invention of Patents No. 1,584,149 and No. 1,584,150 and No. 1,896,020, regardless of the fact that the invention was made in a foreign country.

(34) In holding and adjudging that the amount of product obtained by The Electric Storage Battery Company in its Tudor Mill was very limited.

(35) In holding and adjudging that The Electric Storage Battery Company had no thought of temperature control to get the maximum degree of oxidation in the drum of the Tudor Mill.

(36) In not holding and adjudging that plaintiff is estopped by reason of the position taken by patentee in the Hall-Shimadzu Interference from asserting or claiming that the process employed by The Electric Storage Battery Company is the process covered by the process claims, or any of them of Patent No. 1,584,150.

(37) In holding and adjudging that a first inventor in taking out a patent has, as a matter of law, the right if he choose, to withhold the really essential steps of the invention.

(38) In holding and adjudging that, as a matter of law, an invention similar to or identical with an invention of a first inventor, and made or brought into use by a second inventor during concealment of the invention by the first inventor can, upon proof of the identity of the second invention with the really essential steps previously invented and withheld by the first inventor, be inhibited or restricted.

(39) In not holding and adjudging that, as a matter of law, a first inventor, Shimadzu, who suppresses and conceals his invention when he filed application for Japanese Patent 42,563 on November 27th, 1920, until he filed on February 3rd, 1923 Japanese Patent 60,825 corresponding to U. S. 1,584,150, loses his patent rights as against a second independent inventor Hall who reduced the invention to prac-

tice June, 1921, during suppression or concealment by the first inventor.

(40) In holding and adjudging, as a matter of law, that the construction of Japanese Patent No. 42,563, should, for the purposes of Section 4887 R. S., be construed literally in respect to Claim 1 and should be construed broadly to include the meaning and purposes given to the patent as a whole by the patentee for purposes of differentiation from Japanese Patent No. 60,825.

(41) In not holding and adjudging, as a matter of law, that the claims of patents are to be construed in the light of their specifications as understood by those skilled in the art.

(42) In holding and adjudging that Shimadzu was entitled to carry his date of invention back more than two years prior to the filing date in respect to patents or printed publications preceding his U. S. filing date and constituting a statutory bar, under R. S. Section 4887.

(43) In not holding and adjudging that Claims 1 to 9, inclusive, and 11 to 13, inclusive, of Patent No. 1,584,150, are severally invalid under R. S. 4885 and 4887, by prior patenting and printed publication for more than two years prior to July 14, 1923, its filing in the United States, in the Belgian Tudor patent 239,406 of May 4, 1920, the Thibault French patent No. 494,270, of September 4, 1919, and others in the prior art.

(44) In not dismissing the bill of complaint for want of equity.



(45) In ordering and adjudging that writ of injunction issue out of and under the seal of this Court directed to the defendant, The Electric Storage Battery Company, enjoining and restraining the said defendant from using or practicing the processes and methods described in Letters Patent No. 1,584,149 and No. 1,594,150 and claimed in Claims 1 and 2 of Letters Patent No. 1,584,149 and Claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of Letters Patent No. 1,584,150 and from making, using or selling apparatus containing or embodying the inventions of Claims 10 and 11 of Patent No. 1,896,020.

(46) In ordering and adjudging that The Electric Storage Battery Company account to plaintiffs.

E. S. W. FARNUM,  
*Solicitor.*

AUGUSTUS B. STOUTON.  
12/14/36.

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CITATION.

(Filed Dec. 19, 1936.)

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UNITED STATES OF AMERICA, SS:

*The President of the United States:*

To GENZO SHIMADZU and NORTHEASTERN ENGINEERING CORPORATION

GREETING:

You are hereby cited and admonished to be and appear at a United States Circuit Court of Appeals for the Third Circuit, to be holden at the City of Philadelphia within thirty days, pursuant to an ap-



1206      Petition for Cross-Appeal by Plaintiffs.

Appeal filed in the Clerk's Office of the District Court of the United States, Eastern District of Pennsylvania, wherein THE ELECTRIC STORAGE BATTERY COMPANY is appellant, and you are appellees to show cause, if any there be, why the Decree rendered against the said appellant as in the said appeal mentioned, should not be corrected, and why speedy justice should not be done to the parties in that behalf.

WITNESS, the Honorable W. H. KIRKPATRICK Judge of the District Court of the United States, this 14th day of December, in the year of our Lord one thousand nine hundred and thirty-six.

W. H. KIRKPATRICK,

December 16, 1936.

*District Judge.*

Service accepted.

JOSEPH W. HENDERSON,

*Attorney for Appellee.*

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PETITION FOR CROSS-APPEAL  
BY PLAINTIFFS.

(Filed Jan. 12, 1937.)

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*To the Honorable the Judges of the United States  
District Court for the Eastern District of Penn-  
sylvania:*

The above named plaintiffs, Genzo Shimadzu and Northeastern Engineering Corporation, conceiving themselves aggrieved by the interlocutory decree made and entered herein on the 14th day of December, A. D., 1936, does hereby appeal from said decree

to the United States Circuit Court of Appeals for the Third Circuit, for the reasons specified in the assignments of error filed herewith, and prays that this appeal be allowed, and that citation be issued as provided by law, directed to the above named defendant, The Electric Storage Battery Company, commanding it to appear before the United States Circuit Court of Appeals for the Third Circuit, to do and receive what may pertain to justice to be done in the premises, and that a transcript of the record, proceedings and documents upon which said decree was made, duly authenticated, be sent to the United States Circuit Court of Appeals for the Third Circuit.

RAWLE & HENDERSON,  
HUNT, HILL & BETTS,  
EDMUND B. WHITCOMB,  
*Solicitors for Plaintiffs.*

Dated, January 12, 1937.

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ORDER ALLOWING APPEAL.  
(Filed Jan. 12, 1937.)

And Now, to-wit, this 12th day of January, A. D., 1937, upon consideration of the attached petition for cross-appeal of the plaintiffs, cross-appellants, and the assignments of error filed herein, and the bond for costs in the sum of \$250.00, with the Aetna Casualty & Surety Company as surety, submitted herewith, it is hereby

ORDERED, that said bond is approved as to amount and surety, and that the cross-appeal prayed for in said petition be and hereby is allowed.

W. H. KIRKPATRICK,  
J.

1208 Plaintiffs' Assignments of Error on Cross-  
Appeal.

PLAINTIFFS' ASSIGNMENTS OF ERROR ON  
CROSS APPEAL.

(Filed Jan. 12, 1937.)

And Now come Genzo Shimadzu and Northeastern Engineering Corporation, plaintiffs below, appellants, by Hunt, Hill & Betts, Edmund B. Whitcomb and Rawle & Henderson, their solicitors, and say that in the record of proceedings and in the decree in the above stated cause, there is manifest error in the following, to wit:

1. In holding and adjudging that claims 14, 15, 16 and 17 of United States Letters Patent No. 1,584,150 have not been proven to have been infringed by defendant.

2. In holding and adjudging that claims 1, 2, 3, 4 and 5 of United States Letters Patent No. 1,584,151 have not been proven to have been infringed by defendant.

3. In holding and adjudging that claims 1, 2, 3 and 4 of United States Letters Patent No. 1,584,479 have not been proven to have been infringed by defendant.

4. In not holding and adjudging that the product manufactured by defendant within six years prior to the filing of the bill of complaint herein contained a comminuted lead lead suboxide mixture with apparent specific gravity 1 to 3, as specified in claim 14 of the Shimadzu patent 1,584,150.

5. In not holding and adjudging that the product manufactured by defendant within six years prior to

Plaintiffs' Assignments of Error on Cross- 1209  
Appeal.

the filing of the bill of complaint herein comprised a highly chemically reactive finely divided powder comprising a major portion of lead suboxide, said powder being capable of spontaneous oxidation, as specified in claim 15 of Shimadzu patent 1,584,150.

6. In not holding and adjudging that the product made within the rotating mills, employed by defendant within six years prior to the filing of the bill of complaint herein comprised a highly chemically reactive finely divided powder comprising a major portion of the lead suboxide, said powder being capable of spontaneous oxidation, as specified in claim 15 of Shimadzu patent 1,584,150.

7. In not holding and adjudging that the product manufactured by defendant within six years prior to the filing of the bill of complaint herein comprised a highly chemically reactive powder, comprising a large portion of lead suboxide, said powder being capable of spontaneous reaction on contact with moisture, as specified in claim 16 of Shimadzu patent 1,584,150.

8. In not holding and adjudging that the product made within the rotating mills employed by defendant within six years prior to the filing of the bill of complaint herein comprised a highly chemically reactive powder, comprising a large portion of lead suboxide, said powder being capable of spontaneous reaction on contact with moisture, as specified in claim 16 of Shimadzu patent 1,584,150.

9. In not holding and adjudging that the product manufactured by defendant within six years prior to the filing of the bill of complaint herein comprised a highly chemically reactive powder, comprising a large

## 1210 Plaintiffs' Assignments of Error on Cross-Appeal.

portion of lead suboxide, said powder being capable of spontaneous reaction on contact with air as specified in claim 17 of the Shimadzu patent 1,584,150.

10. In not holding and adjudging that the product made within the rotating mills employed by defendant within six years prior to the filing of the bill of complaint herein comprised a highly chemically reactive powder, comprising a large portion of lead suboxide, said powder being capable of spontaneous reaction on contact with air as specified in claim 17 of Shimadzu patent 1,584,150.

11. In holding and adjudging that the process employed by defendant within six years prior to the filing of the bill of complaint herein did not involve the method of forming finely divided lead oxide in the manner as stated in each of claims 1, 2, 3 and 4 of Shimadzu patent 1,584,151.

12. In not holding and adjudging that the process as practiced by defendant within six years prior to the filing of the bill of complaint herein, within the rotating mills employed by defendant, included, as stated in the claims of Shimadzu patent 1,584,151 the formation of finely divided oxygenated lead compounds by treating a finely divided chemically reactive powder comprising a major portion of lead suboxide with an oxidizing substance.

13. In not holding and adjudging that the process as practiced by defendant within the rotating mills employed by defendant within six years prior to the filing of the bill of complaint herein, included, as stated in the claims of Shimadzu patent 1,584,151, the formation of finely divided oxygenated lead com-

Plaintiffs' Assignments of Error on Cross- 1211  
Appeal.

pounds by treating a finely divided chemically reactive powder comprising a major portion of lead suboxide with an oxidizing substance, and maintaining the reaction by the evolved heat of reaction.

14. In not holding and adjudging that the process employed by defendant within six years prior to the filing of the bill of complaint herein, in manufacturing plates for storage batteries, involved kneading lead suboxide intermingled with lead monoxide, with or without metallic lead, and sufficient liquid to form a paste and applying the same to or filling therewith the plates or grids, in the manner specified in the claims of the Shimadzu patent No. 1,584,479. . . 4

15. In not extending the injunction in paragraph 10 of the decree herein to claims 14, 15, 16 and 17 of Shimadzu patent 1,584,150; claims 1, 2, 3, 4 and 5 of Shimadzu patent 1,584,151 and claims 1, 2, 3 and 4 of Shimadzu patent 1,584,479.

16. In not extending the recovery directed in paragraph 11 of the decree herein to include the defendant's profits, gains and/or advantages and also the damages suffered by plaintiffs by reason of defendant's infringement of claims 14, 15, 16 and 17 of Shimadzu patent 1,584,150; claims 1, 2, 3, 4 and 5 of Shimadzu patent 1,584,151 and claims 1, 2, 3 and 4 of Shimadzu patent 1,584,479.

17. In not extending the accounting directed in paragraph 12 of the decree herein to the profits, gains and/or advantages made by the defendant and the damages suffered by plaintiffs by reason of the defendant's infringement of claim 14, 15, 16 and 17 of Shimadzu patent 1,584,150; claims 1, 2, 3, 4 and 5 of

Shimadzu patent 1,584,151 and claims 1, 2, 3. and 4 of Shimadzu patent 1,584,479.

18. In finding and adjudging that commercial production by the Hardinge mill with its forced draft involving the use of plaintiff's patent began in June 1921.

RAWLE & HENDERSON,  
HUNT, HILL & BETTS,  
EDMUND B. WHITCOMB,  
*Solicitors for Plaintiffs.*

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CITATION.

(Filed Jan. 13, 1937.)

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UNITED STATES OF AMERICA, ss.

THE PRESIDENT OF THE UNITED STATES,

*To The Electric Storage Battery Company*

GREETING:

You are hereby cited and admonished to be and appear at a United States Circuit Court of Appeals for the Third Circuit, to be holden at the City of Philadelphia within thirty days, pursuant to an appeal filed in the Clerk's Office of the District Court of the United States, Eastern District of Pennsylvania, wherein Genzo Shimadzu and Northeastern Engineering Corporation are appellants and you are appellee to show cause, if any there be, why the decree rendered against the Electric Storage Battery Company as in the said appeal mentioned, should not be corrected, and why speedy justice should not be done to the parties in that behalf.



WITNESS, the Honorable Wm. H. Kirkpatrick, Judge of the District Court of the United States; this 12th day of January, in the year of our Lord one thousand nine hundred and thirty-seven.

W. H. KIRKPATRICK,  
*District Judge.*

January 1937.  
Service accepted.

AUGUSTUS B. STOUGHTON  
E. S. W. FARNUM, JR.  
*Attorneys for Electric Storage Battery Company.*

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PRAECIPE FOR TRANSCRIPT OF RECORD.  
(Filed July 3, 1937.).

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*To the Clerk of the District Court of the United States  
for the Eastern District of Pennsylvania:*

You are hereby requested to prepare and certify the transcript of record to be filed in the United States Circuit Court of Appeals for the Third Circuit pursuant to an appeal allowed in the above-entitled causes and to include in said transcript the following:

1. Docket entries.
2. Bill of Complaint.
3. Answer.
4. Motion by Plaintiffs for Leave to Inspect Defendant's Plant, filed December 19, 1933.
5. Affidavit of L. S. Ishimura, filed Dec. 19, 1933.
6. Defendant's Answer to Motion and Affi-

deavits of J. R. Williams, E. W. Smith, Clarence A. Hall, J. L. Woodbridge, and C. Reed Cary, filed December 19, 1933.

7. Affidavit of E. W. Smith, filed Dec. 20, 1933.

8. Defendant's Motion for Bill of Particulars, filed June 8, 1935.

9. Interrogatories Propounded by Defendant to Plaintiffs, filed June 8, 1935.

10. Interrogatories Propounded by Plaintiffs to Defendant, pursuant to Equity Rule 58.

11. Plaintiff's Motion for Further and Better Particulars of Defenses.

12. Defendant's Bill of Particulars, filed Aug. 29, 1935.

13. Answer by R. C. Norberg to Plaintiff's Interrogatories, filed Aug. 29, 1935.

14. Answer to Interrogatories Propounded by Defendant to Plaintiffs, filed Sept. 19, 1935.

15. Plaintiffs' Bill of Particulars, filed September 19, 1935.

16. Order for Issuance of Letters Rogatory to Kyoto, Japan.

17. Opinion of Kirkpatrick, J., filed Oct. 6, 1936.

18. Memorandum amending opinion, filed Nov. 20, 1936.

19. Final Decree, filed Dec. 14, 1936.

20. Petition for an Appeal, filed Dec. 14, 1936.

21. Order Allowing an Appeal, filed Dec. 14, 1936.

22. Assignments of Error, filed Dec. 14, 1936.

23. Citation on Appeal, returned Dec. 19, 1936.

24. Petition for Cross-Appeal by Plaintiffs, filed Jan. 12, 1937.

25. Order allowing Appeal, filed Jan. 12, 1937.

26. Plaintiffs' Assignments of Error, filed Jan. 12, 1937.

27. Citation on Appeal, filed Jan. 12, 1937.

28. Plaintiffs' Physical Exhibits according to attached list (to be certified but not reproduced).

29. Defendant's Physical Exhibits according to attached list (to be certified but not reproduced).

30. Stipulation concerning statement of testimony and evidence, filed April 19, 1937, and statement of the evidence as specified in and attached to said Stipulation.

31. Order approving foregoing Stipulation, filed April 19, 1937.

32. This Praecepta.

33. Certificate of Transcript.

HUGH M. MORRIS,

AUGUSTUS B. STOUGHTON,

E. S. W. FARNUM, JR.,

*Solicitors for Defendant-Appellant  
and Appellee in Cross-Appeal.*

May 24, 1937

Philadelphia, Pennsylvania.

We hereby acknowledge service of copy of the foregoing praecipe this 24th day of May, 1937, and agree that the same embraces all of the papers and documents which plaintiffs-cross appellants desire incorporated in the transcript on appeal.

RAWLE & HENDERSON,  
HUNT, HILL & BETTS,  
*Solicitors for Plaintiffs-Appellees  
and Appellants in Cross Appeal.*

PHYSICAL EXHIBITS  
(no-duplicates)

PLAINTIFFS'

- 7 —Ishimurā's Japanese Note-book, Sept. 1918 to  
July, 1919
- 8 — " " " " July, 1919 to  
March, 1921
- 22 —Sample of material
- (a) —Sealed Tube of Powder from Defendant's Mill
- (b) — " " " " " "
- (c) — " " " " " "
- (d) — " " " " " "
- (e) — " " " " " "
- (f) —Lead Ball from Defendant's Mill
- (g) —Lead Ball
- 23-A-1—Film relating to Plaintiffs' Exhibit 22-A
- 23-A-2— " " " " " "
- 23-A-3— " " " " " "
- 23-D-1— " " " " " 22-D

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|---------|---|---|---|---|---|------|
| 23-D-2— | “ | “ | “ | “ | “ | “    |
| 23-D-3— | “ | “ | “ | “ | “ | “    |
| 23-E-1— | “ | “ | “ | “ | “ | 22-E |
| 23-E-2— | “ | “ | “ | “ | “ | “    |
| 23-E-3— | “ | “ | “ | “ | “ | “    |
| 23-G-1— | “ | “ | “ | “ | “ | 22-G |
| 23-G-2— | “ | “ | “ | “ | “ | “    |
| 23-G-3— | “ | “ | “ | “ | “ | “    |
| 23-G-4— | “ | “ | “ | “ | “ | “    |
| 23-H-1— | “ | “ | “ | “ | “ | 22-H |
| 23-H-2— | “ | “ | “ | “ | “ | “    |
| 23-H-3— | “ | “ | “ | “ | “ | “    |

23-I-1 —X-Ray Films of Powder from Mill No. 3, Run.  
31, Aug. 3, 1934

23-I-2 —X-Ray Films of Powder from Mill No. 3, Run.  
31, Aug. 3, 1934

28(a) —Film of sample of Exide Oxide number 94B

(b) — “ “ “ “ Prest-O-Lite Oxide

(c) — “ “ “ “ “ “ “ “

32 —Negative Group of Plates (Kyle)

33 —Positive “ “ “ “

34 —Wooden Separators “

35 —Battery Unit “

54 —Film entitled “Special Nickel Filtered Radiation”

55 —Glass Tube containing fractionated sample

60 —Film of Aged and exposed Exide sample

PHYSICAL EXHIBITS  
(no duplicates)

DEFENDANT'S.

- 75 —Sealed Tube containing sample of powder taken from Toronto Mill
- 138 —Dr. Davey's Note-book No. 1
- 139 — " " " " " 4
- 140 — " " " " " 2
- 141 — " " " " " 3
- 142 —Work sheet showing Lead Oxalate decomposition product after two hours at 310 deg.  
(a)—Film for Exhibit 142
- 143 —Work Sheet "Transcription of Oxalate Films"  
(a) Film of Exhibit 143
- 144 —X-Ray Analysis of Gray Oxide (Finished Product)  
(a) Film of Exhibit 144
- 145 —X-Ray Analysis of Gray Oxide (Finished Product)  
(a) —Film of Exhibit 145
- 146 —X-Ray Analysis of Gray Oxide (Under Screen) first official sample  
(a) —Film of Exhibit 146
- 147 —X-Ray Analysis of Pb and PbO (Mechanical mixture of 67.51% 32.49%)  
(a)—Film of Exhibit 147
- 148 —Lead Ball taken from inside of Mill near discharge end. X-Ray Analysis of Powder from Surface of Lead Ball.  
(a)—Film of Exhibit 148.

- 149 —X-Ray Analysis of Gray Oxide (Under Screen) second official sample  
(a)—Film of Exhibit 149
- 150 —X-Ray Analysis of Gray Oxide (Screen Product over  $P_2O_5$ )  
(a)—Film of Exhibit 150
- 151 —X-Ray Analysis of Gray Oxide (Finished Product  $P_2O_5$ )  
(a)—Film Exhibit 151
- 157 —Dr. Davey's films of E.S.B.Co.'s Gray Oxide
- 158 —“ “ “ “ “ “ “ “ “ “
- 159 —Box of films
- 160 —“ “ “
- 178 —X-Ray Analysis of decomposition product of Lead Oxalate and “Interplaner Spacings of Decomposition product of Lead Oxalate.”  
(a)—Film of Exhibit 178
- 180 —Box containing card (colored)
- 183 —Half of Lead Ball (Dr. Ullmann)

UNITED STATES OF AMERICA }  
EASTERN DISTRICT OF PENNSYLVANIA } ss:

I, George Brodbeck, Clerk of the United States District Court in and for the Eastern District of Pennsylvania, do hereby certify that the annexed and foregoing is a true and full copy of so much of the pleas and proceedings; in the case of Genzo Shimadzu and Northeastern Engineering Corporation vs. The Elec-



tric Storage Battery Co., No. 7727 March Term, 1933, as per praecipe filed, (with exception of exhibits), a copy of which is hereto attached, the transcript of record in the above entitled cause is to include — — — now remaining among the records of the said Court in my office.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the seal of  
(Seal) the aforesaid Court at Philadelphia this  
day of October, A. D. 1937.

GEORGE BRODBECK,

*Clerk.*

*Order Assigning Hon. Oliver B. Dickinson for* 1221  
*Argument*

**ORDER ASSIGNING HON. OLIVER B. DICKINSON  
FOR ARGUMENT.**

(Filed May 12, 1938.)

IN THE UNITED STATES CIRCUIT COURT OF APPEALS,  
FOR THE THIRD CIRCUIT.

No. 6309. March Term, 1938.

*Electric Storage Battery Company,*  
Appellant,

v.

*Genzo Shimadzu and Northeastern Engineering Corp.,*  
Appellee.

APPEAL FROM THE DISTRICT COURT OF THE UNITED  
STATES FOR THE EASTERN DISTRICT OF PENNSYLVANIA.

And now, to wit: this twelfth day of May, A. D. 1938, it is ordered that Hon. Oliver B. Dickinson, District Judge for the Eastern District of Pennsylvania, be and he is hereby assigned to sit in above case in order to make a full court.

JOSEPH BUFFINGTON,  
Circuit Judge.

(Endorsements.)—Order Assigning Hon. Oliver B. Dickinson for Argument Received and Filed May 12, 1938. Wm. P. Rowland, Clerk.

**REFERENCE TO ARGUMENT.**

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IN THE UNITED STATES CIRCUIT COURT OF APPEALS,  
FOR THE THIRD CIRCUIT.

---

No. 6309. October Term, 1937.

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*Electric Storage Battery Co.,*  
Defendant-Appellant,

v.

*Genzo Shimadzu and Northeastern Engineering Corp.,*  
Plaintiffs-Appellees.

---

And afterwards, to wit, the twelfth day of May, 1938, come the parties aforesaid by their counsel aforesaid, and this case being called for argument sur pleadings and briefs, before the Honorable Joseph Buffington and Honorable J. Warren Davis, Circuit Judges, and Honorable Oliver B. Dickinson, Judge, and the Court not being fully advised in the premises, takes further time for the consideration thereof,

And afterwards, to wit, on the eighth day of August, 1938, come the parties aforesaid by their counsel aforesaid, and the court, now being fully advised in the premises, renders the following decision:

IN THE  
UNITED STATES CIRCUIT COURT OF APPEALS,  
FOR THE THIRD CIRCUIT.

—  
No. 6309. October Term, 1937.

—  
THE ELECTRIC STORAGE BATTERY CO.,  
*Defendant-Appellant,*  
v.

GENZO SHIMADZU AND NORTHEASTERN  
ENGINEERING CORPORATION,  
*Plaintiffs-Appellees.*

—  
No. 6336. October Term, 1937.

—  
GENZO SHIMADZU AND NORTHEASTERN  
ENGINEERING CORPORATION,  
*Plaintiffs-Cross-Appellants,*  
v.

THE ELECTRIC STORAGE BATTERY CO.,  
*Defendant-Cross-Appellee.*

—  
APPEALS FROM THE DISTRICT COURT OF THE UNITED  
STATES FOR THE EASTERN DISTRICT OF PENNSYL-  
VANIA.

—  
**OPINION.**

(Filed August 8, 1938.)

—  
Before BUFFINGTON and DAVIS, *Circuit Judges*, and  
DICKINSON, *District Judge*.

—  
PER CURIAM:

Genzo Shimadzu as owner and patentee and the  
Northeastern Engineering Company as exclusive

licensee, of six patents, brought suit in the District Court against the Electric Storage Battery Company, defendant, for infringement of these patents. That Court entered a decree finding the following claims valid and infringed: claims 1 and 2 of patent No. 1,584,149; claims 1, 2, 3, 4, 6, 8, 9, 10, 11, 12 and 13 of patent No. 1,584,150; and claims 10 and 11 of patent No. 1,896,020. It also held the following claims valid but not infringed: claims 14, 15, 16 and 17 of patent No. 1,584,150; claims 1, 2, 3, 4, and 5 of patent No. 1,584,151; claims 1 and 2 of patent No. 1,584,152; and claims 1, 2, 3, and 4 of patent No. 1,584,479. Upon these findings, the District Court issued an appropriate injunction and ordered an accounting of profits and damages. Both the plaintiffs and the defendant have appealed to this court.

These patents contain process and apparatus claims relating to the manufacture of a fine powder of lead or lead oxide; claims relating to the manufacture of lead suboxide powder; product claims for lead suboxide; claims relating to the use of lead suboxide powder in a process for further oxidation into such products as litharge and red lead; and claims relating to the use of lead suboxide powder in the manufacture of plates for storage batteries and paints.

The claims held valid and infringed were the process and apparatus claims relating to the manufacture of the fine powder of lead or lead oxide. The other claims all refer to lead suboxide and these were all held void but not infringed because of the doubt surrounding the existence of that product.

Several questions are here at issue. These involve the validity of the patents under section 4887 of the Revised Statutes, (35 U. S. C. A. 32); the validity of the patents in view of the prior art, and the existence of the product lead suboxide.

After a careful examination of the record and briefs, we are of the opinion that the facts found by the learned District Judge are based upon substantial evidence, that he has properly applied the law to these facts and reached correct conclusions.

Accordingly we affirm the decree upon his opinion.

A true Copy:

Teste:

*Clerk of the United States Circuit Court of Appeals  
for the Third Circuit.*

**ORDER AFFIRMING DECREE.**

(Filed August 8, 1938.)

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IN THE UNITED STATES CIRCUIT COURT OF APPEALS,  
FOR THE THIRD CIRCUIT.

---

No. 6309. October Term, 1937.

---

*Electric Storage Battery Co.,*  
Defendant-Appellant,  
v.

*Genzo Shimadzu and Northeastern Engineering Corp.,*  
Plaintiffs-Appellees.

---

APPEAL FROM THE DISTRICT COURT OF THE UNITED  
STATES, FOR THE EASTERN DISTRICT OF PENNSYL-  
VANIA.

---

This cause came on to be heard on the transcript of record from the District Court of the United States, for the Eastern District of Pennsylvania, and was argued by counsel.

On consideration whereof, it is now here ordered, adjudged, and decreed by this Court that the decree of the said District Court in this cause be, and the same is hereby affirmed, with costs.  
Philadelphia,

J. WARREN DAVIS,  
*Circuit Judge.*

August 8, 1938.

(Endorsements.)—Order Affirming Decree Received and Filed August 8, 1938. Wm. P. Rowland, Clerk.



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IN THE  
**United States Circuit Court of Appeals**  
FOR THE THIRD CIRCUIT.

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**No. 6309.**

**October Term, 1937.**

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**THE ELECTRIC STORAGE BATTERY CO.,**  
*Defendant-Appellant,*

*v.*

**GENZO SHIMADZU and NORTHEASTERN  
ENGINEERING CORPORATION,**  
*Plaintiffs-Appellees.*

---

**Petition of Defendant-Appellant for Rehearing  
and Supporting Brief.**

---

**AUGUSTUS B. STOUGHTON,  
HUGH M. MORRIS,  
A. F. KWIS,  
E. S. W. FARNUM, JR.,**  
*Counsel for Defendant-Appellant.*

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IN THE  
**United States Circuit Court of Appeals**  
FOR THE THIRD CIRCUIT.

THE ELECTRIC STORAGE BATTERY CO.,  
*Defendant-Appellant,*

No. 6309.

v.

GENZO SHIMADZU and NORTHEASTERN  
ENGINEERING CORPORATION,

October Term,

1937.

*Plaintiffs-Appellees.*

**PETITION OF DEFENDANT-APPELLANT FOR  
REHEARING.**

Now comes The Electric Storage Battery Co., defendant-appellant in the above-entitled cause, and respectfully prays that said cause be reheard and reconsidered by this Honorable Court, for the following reasons:

(1) This Honorable Court inadvertently overlooked the fact that the very process here held to be an infringement of plaintiff's '150 patent was, by the express finding of the court below, in commercial use in defendant's Hardinge mill in June, 1921, more than two years prior to the filing of application for '150, and that such prior commercial use invalidates '150 under the express terms of R. S. 4887.

(2) This Honorable Court inadvertently overlooked the fact that plaintiff's '150 patent is invalidated, under the express terms of R. S. 4887, for the reason that, as found by the court below, the process thereof was known and used in defendant's Hardinge

## 2 Defendant-Appellant's Petition for Rehearing

mill prior to the earliest date to which plaintiff can carry back the invention of '150, either in fact or in law.

(3) Although this court concurred in the finding of the court below, that commercial production by defendant's Hardinge mill, "which embodied the plaintiff's principles," began in June, 1921, it apparently overlooked the fact that such finding invalidates plaintiff's '020 patent under the express terms of R. S. 4886.

(4) In affirming the holding of the court below that plaintiff's '149 patent is valid and infringed, this Honorable Court inadvertently overlooked the fact that Japanese Patent 41,728 is substantially identical with claim 1 of '149 and that Japanese Patent 42,563 is substantially identical with claim 2 of '149 and that those patents, having been applied for in Japan more than twelve months prior to the filing of application for '149, nullify '149 under the express terms of R. S. 4887.

(5) In its agreement with the conclusion of the court below that defendant's Tudor mill operation, though not an abandoned experiment, "cannot be considered as a prior public use against the patents in suit" because "there was absolutely no suggestion or thought of blowing or forcing the air into the drum" and because "the defendant never had the slightest conception of the effect which even this gentle circulation of air had upon the lead surface to be abraded," this Honorable Court inadvertently overlooked the positive documentary evidence which clearly establishes the contrary.

(6) This Honorable Court apparently overlooked the fact that the finding by the court below of infringement of plaintiff's '149 patent by defendant's Har-

*Defendant-Appellant's Petition for Rehearing* 3

dinge mill process is conclusively refuted by the clear preponderance of evidence.

Wherefore, defendant-appellant prays that said cause be reheard and reconsidered by this Honorable Court upon the grounds and for the reasons aforesaid.

AUGUSTUS B. STOUGHTON,  
HUGH M. MORRIS,  
A. F. KWIS,  
E. S. W. FARNUM, JR.,  
*Counsel for Defendant-Appellant.*

**CERTIFICATE OF COUNSEL.**

I hereby certify that this petition for rehearing is not filed for purposes of delay and is, in my opinion, well founded in law.

AUGUSTUS B. STOUGHTON,  
*Solicitor and Of Counsel for  
Defendant-Appellant.*



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## DEFENDANT'S SUPPORTING BRIEF.

## ARGUMENT.

## I.

THIS HONORABLE COURT INADVERTENTLY OVERLOOKED THE FACT THAT THE VERY PROCESS HERE HELD TO BE AN INFRINGEMENT OF PLAINTIFF'S '150 PATENT WAS, BY THE EXPRESS FINDING OF THE COURT BELOW, IN COMMERCIAL USE IN DEFENDANT'S HARDINGE MILL IN JUNE, 1921, MORE THAN TWO YEARS PRIOR TO THE FILING OF APPLICATION FOR '150, AND THAT SUCH PRIOR COMMERCIAL USE INVALIDATES '150 UNDER THE EXPRESS TERMS OF R. S. 4887.

R. S. 4887 (35 U. S. C. A. § 32) deals with the effect, upon a domestic application, of a patent previously secured in a foreign country for the same invention and of the application for such foreign patent.

It says:

"No person otherwise entitled thereto shall be debarred from receiving a patent for his invention . . . , nor shall any patent be declared invalid by reason, of its having been first patented or caused to be patented by the inventor or his legal representatives or assigns in a foreign country, unless the application for said foreign patent was filed more than twelve months, . . . prior to the filing of the application in this country, in which case no patent shall be granted in this country."

And,

"An application for patent for an invention . . . filed in this country by any person who has previously regularly filed an application for a pat-

ent for the same invention, . . . in a foreign country . . . shall have the same force and effect as the same application would have if filed in this country on the date on which the application for patent for the same invention, . . . was first filed in such foreign country: Provided, That the application in this country is filed within twelve months . . . from the earliest date on which any such foreign application was filed."

The statute thus operates to deprive a foreign patent of the anticipating effect which, under R. S. 4886, it might otherwise have upon a domestic application for the same invention, provided the application in this country is filed within twelve months from the date of filing of the foreign application; and, under like conditions, it gives to a domestic application the benefit of the foreign application date.

But these exceptions to R. S. 4886 are not absolute. They are subject to the mandatory limitation with which the act concludes:

"But no patent shall be granted on an application for patent for an invention or discovery or a design which had been patented or described in a printed publication in this or any foreign country more than two years before the date of the *actual filing* of the application in this country, *or which had been in public use or on sale in this country for more than two years prior to such filing.*"\*

Commenting on this statute, Stringham, Outline of Patent Law (1937), says (§ 1780):

"A convention filing has, in general, the effect of an earlier domestic filing, *but it does not prevent the running of the two-year statutory bar.*"

The court below held Claims 1 to 4, 6 and 9 to 13 of United States Patent '150, (being all of the process claims of that patent in suit) valid and infringed, and found:

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\*Italics throughout defendant's.

## Argument

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"In July, 1920, the defendant set about installing a full-sized plant for the manufacture of lead powder at Philadelphia. Mr. Hall was engaged for that purpose. . . . he decided upon what he referred to as a 'radical change' from the German mill. As a matter of fact, he discarded it altogether and proceeded to install an entirely different type, *which embodied the plaintiff's principles and in which the principal element was a Hardinge conical mill.* (R. II, 1174.)

"*. . . Commercial production by the Hardinge mill with its forced air draft undoubtedly involved the use of the plaintiff's patent, and June, 1921, may be fixed as the date when that began.*" (R. II, 1175.)

There was thus an express, positive and unqualified finding and conclusion by the court below, concurred in by this court, that defendant's Hardinge mill embodied the principles and involved the use of the process claims of '150, and that such Hardinge mill was in public use in Philadelphia not later than June, 1921.

But plaintiff's '150 patent was not applied for until July 14, 1923 (PX 3). Consequently, the application for '150 was not filed until the invention thereof "had been in public use . . . in this country for more than two years prior to such filing." It is believed this fact was inadvertently overlooked by the court.

## II.

**THIS HONORABLE COURT INADVERTENTLY OVERLOOKED THE FACT THAT PLAINTIFF'S '150 PATENT IS INVALIDATED, UNDER THE EXPRESS TERMS OF R. S. 4887, FOR THE REASON THAT, AS FOUND BY THE COURT BELOW, THE PROCESS THEREOF WAS KNOWN AND USED IN DEFENDANT'S HARDINGE MILL PRIOR TO THE EARLIEST DATE TO WHICH PLAINTIFF CAN CARRY BACK THE INVENTION OF '150, EITHER IN FACT OR IN LAW.**

By the unequivocal finding of the court below, which this court deemed "based upon substantial evidence," the process of '150 was in use in commercial production by defendant's Hardinge mill in Philadelphia not later than June, 1921. *A fortiori*, the process of '150 was then known and used by others than plaintiff in this country, and, by the express terms of R. S. 4886, Patent '150 is thereby invalidated, unless plaintiff can establish a date of invention therefor, to which he is legally entitled, prior to June, 1921. But that he cannot do, either (a) in fact, or (b) in law.

(a) The court below thus analyzed the process of '150 (R. II, 1167):

"It calls for the following steps:

1. *Impinging a current of air on lead masses in a dry state;*
2. *Abrading the lead masses;*
3. *Controlling the temperature to obtain a finely divided powder containing a large proportion of oxidized lead."*

The court below found (R. II, 1175):

"The essence of the plaintiff's patent, . . . is forcing a continuous blast of air into the drum at a

controlled high temperature so that *oxygen* will be absorbed by the lead and form a brittle *oxidized* surface which could be rapidly abraded off."

Thus, it was found by the court below that the central and indispensable element of plaintiff's invention is the *oxidizing* effect of the air introduced into the drum.

The court below surmised (R. II, 1165) that plaintiff, "with the scientific resources and expert assistance at his command," "must have known that oxidation would be accelerated by the introduction of the air current" and accordingly fixed the date of invention and successful reduction to practice as not later than August, 1919, remarking:

"I think it clear that he (Shimadzu) had enough appreciation of what was necessary to obtain the desired result for me to fix the date of invention at or before the time referred to." (R. II, 1166.)

If, therefore, it is true that plaintiff did, in August, 1919, perceive the *oxidizing* effect of the air, he must have had the same knowledge on November 27, 1920, when he filed application for Japanese Patent 42,563.

But, with respect to Japanese Patent '563, the court below said:

"The first thing that strikes one is that there is not the slightest suggestion of any *oxidizing* effect of the current of gas which is introduced into the mill. On the contrary, it would seem that there was a definite purpose to avoid *oxidation*." (R. II, 1169.)

And,

"The best guess that one can make of what he had in mind was, that he meant to patent a process for mechanically removing fine powder from the drum by means of a current of some non-oxi-

dizing medium, and that he believed that air with its high percentage (78%) of nitrogen, if delivered at a low temperature, would be sufficiently inert to serve his purpose and prevent combustion with the drum." (R. II, 1170.)

These findings, which apparently escaped the attention of this court, demonstrate, it is believed, that plaintiff did not perceive the *oxidizing* effect of the air introduced into the drum (the sine qua non of the '150 process) on November 27, 1920 and, consequently, that he had not and could not have attained the invention of that patent in August, 1919.

The exact date when plaintiff did arrive at the basic concept of the invention, however, is not in doubt. It is conclusively established by the unassailable documentary evidence adduced by plaintiffs themselves in PX 11. That exhibit is a photograph showing the appearance of lead balls after seven hours rumbling in an atmosphere of carbon dioxide. No powder was produced. The balls were merely polished (R. I, 151, 173). The test was made by Shimadzu "to find out what the air does" (R. I, 178). At the trial Ishimura testified that the experiment of Exhibit 11 was conducted in 1919 (R. I, 151, 152, 173) or 1921 (R. I, 178). Subsequently, while putting the record in form for this appeal, defendant discovered that PX 11 itself records the date on which the carbon dioxide experiment was made, and that that date was *January 27, 1923*.\*

On February 3, 1923, scarcely more than a week after the experiment of PX 11, plaintiff filed in Japan

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\*In their answer, filed in this Court to defendant's petition for leave to apply to the District Court to reopen the case and take new evidence, plaintiff, referring to the label on the bottle in PX11, stated:

"A correct translation reads as follows:

'Carbon Dioxide Gas Experiment 12th year of Taisho, 1st month, 27th day, The lead balls after 7 hours rotation.  
Taisho (the reign of the Old Emperor Yoshihito), began in July, 1912, so the 12th year of Taisho would be the year 1923 . . . .'



application for Patent 60,825, which the court below found "corresponds very closely with U. S. '150."

Could there be any more convincing proof that plaintiff's conception of the very heart of the '150 process was simultaneous with the experiment of PX 11 and had not been attained before January 27, 1923, long after the invention was known and used in defendant's Hardinge mill, which the court found to be in commercial production in June, 1921.

Yet that evidence apparently escaped the attention of this court.

(b) But even if it be assumed, notwithstanding the foregoing evidence, that the process of '150 was conceived and actually reduced to practice by plaintiff in Japan prior to June, 1921, nevertheless, plaintiff cannot, under the law, carry the date of his invention of '150 back of the date on which application for Japanese Patent 60,825 for the invention was first filed in Japan. That date was February 3, 1923. But, as found by the court below, the process of '150 had then been known and used in this country in defendant's Hardinge mill since at least as early as June, 1921.

The court below found that Japanese Patent 60,825 "corresponds very closely with U. S. '150" (R. II, 1172). '150 was granted May 11, 1926, upon application filed July 14, 1923 (PX 3). Japanese Patent 60,825 was granted June 19, 1924 upon application filed February 3, 1923. (PX 61.)

We are therefore here concerned solely with the rights in this country of an inventor who has first patented or caused the invention to be patented in a foreign country. Such rights are expressly governed by R. S. 4887. That statute says:

"An application for patent for an invention . . . filed in this country by any person who has previously regularly filed an application for a pat-

ent for the same invention . . . in a foreign country, . . . shall have the same force and effect as the same application would have if filed in this country on the date on which the application for patent for the same invention, . . . was first filed in such foreign country: Provided, That the application in this country is filed within twelve months . . . from the earliest date on which any such foreign application was filed."

Assuming, as the court below found, that the invention of Japanese Patent '825 is the same as U. S. '150, R. S. 4887 thus gives to plaintiff's application for '150 the benefit of the filing date of the Japanese '825. But the statute likewise operates, according to the great weight of authority, as an absolute limitation upon the right of plaintiff to carry the date of invention back of the date of filing of the Japanese application.

*Wilson v. Sherts*, 81 F. (2d) 755.

*Rebuffat v. Crawford*, 68 F. (2d) 980, 982.

*De Kando v. Armstrong*, 37 App. D. C. 314.

*Westinghouse Mach. Co. v. General Electric Co.*, 207 F. 75.

*Jay v. Weinberg*, 250 F. 469, aff'd 262 F. 973.

*Patents Selling & Exporting Co. v. Dunn*, 213 F. 40.

*Vacuum Engineering Co. v. Dunn*, 209 F. 219.

The court below held (R. II, 1178):

"The plaintiff is undoubtedly entitled to rely for priority upon the date of invention and reduction to practice as found, regardless of the fact that the invention was made in a foreign country."

upon the authority of *Claude Neon Lights v. Rainbow Light*, 47 Fed. (2d) 345 and *Hanifen v. E. H. Godshalk*, 78 Fed. 811.

But neither of those cases can be considered as an authoritative decision upon the point in question or as casting doubt upon the soundness of the established construction of the statute.

The conclusion reached by Judge Campbell in 47 Fed. (2d) is based upon the cases of *Welsbach Light Co. v. American Incandescent Lamp Co.*, 98 Fed. 613; *Hanifen v. E. H. Godshalk*, 78 Fed. 811; *Hanifen v. Price*, 96 Fed. 435 and 102 Fed. 509; and *Badische Anilin & Soda Fabrik v. A. Klipstein & Co.*, 125 Fed. 543.

But with the exception of *Hanifen v. E. H. Godshalk Co.*, 78 Fed. 811, and *Hanifen v. Price*, 96 Fed. 435, none of the cases referred to by Judge Campbell supports the proposition for which it is cited. On the contrary, such cases squarely conform to the established rule that a foreign inventor may take back the date of his invention upon an issue of priority only to the date of the actual filing of his application for a foreign patent.

Thus, in *Welsbach Light Co. v. American Incandescent Lamp Co.*, 98 Fed. 613, 616, the C. C. A. 2 said:

"Our conclusion is that, as against an infringer, the patentee in a United States patent for an invention previously made by him and patented in a foreign country may, to avoid alleged use in this country by an infringer before the date of the foreign patent, show the date of the application for the foreign patent, for the purpose of showing the actual date of his invention in a foreign country."

In *Hanifen v. Price*, 102 Fed. 509, the precise question was not considered by the court.

And, in *Badische Anilin & Soda Fabrik v. A. Klipstein & Co.*, 125 Fed. 543, 552, the holding was identical with that in the *Welsbach* case.

The decision in *Hanifen v. Price*, 96 Fed. 435 was reversed by the C. C. A. 2, 102 Fed. 509. The district court, however, followed the reasoning of Judge Dallas in the earlier case of *Hanifen v. E. H. Godshalk Co.*, 78 Fed. 811, and its conclusion upon the question is therefore dependent for its authority upon the decision of Judge Dallas. That decision was likewise reversed by this court in 84 Fed. 649, upon other grounds. But apart from that fact, the decision is wholly without pertinency or effect upon the question here involved. The case was decided December 16, 1896. R. S. 4887 then stood as originally enacted in 1870, and provided only that:

“No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application.”

As thus enacted, the statute obviously was not concerned with any limitation upon the right of a foreign patentee to secure a patent in this country for the same invention, other than by the limitation, carried into the present statute, that the invention shall not have been in public use in this country for more than two years prior to the application here, or with the effect of the application for such foreign patent. The court was therefore justified in stating:

“There is no statute which warrants the suggested distinction respecting inventions made abroad and those made in the United States.”

The case, therefore, has no application to R. S. 4887 as presently amended by the Acts of March 3, 1903 and June 19, 1936, and cannot be considered as a

precedent for the construction of the statute here involved. For the same reason, the case of *Hanifen v. Price*, 96 Fed. 435, cannot be regarded as an authority upon the present question.

The foregoing considerations, which invalidate Patent '150 under R. S. 4887, were, it is believed, inadvertently overlooked by this court.

### III.

**ALTHOUGH THIS COURT CONCURRED IN THE FINDING OF THE COURT BELOW THAT COMMERCIAL PRODUCTION BY DEFENDANT'S HARDINGE MILL, "WHICH EMBODIED THE PLAINTIFF'S PRINCIPLES," BEGAN IN JUNE, 1921, IT INADVERTENTLY OVERLOOKED THE FACT THAT SUCH FINDING INVALIDATES PLAINTIFF'S '020 PATENT UNDER THE EXPRESS TERMS OF R. S. 4886.**

The court below held Claims 10 and 11 of plaintiff's '020 patent (being all of the claims thereof in suit) valid and infringed and found (R. II, 1188-9), upon what this court characterized as substantial evidence:

"The apparatus patent ('020) is closely related, of course, to the process patents. Practically all of the considerations which apply to the one apply to the other, including the Tudor mill and other alleged prior art structures. Having held the process claims valid and infringed; the same conclusion is reached with regard to the apparatus patent."

'020 has no counterpart in any foreign patent here in evidence. The validity of that patent is therefore governed by R. S. 4886 (35 U. S. C. A. § 31), unaffected by any right or limitation arising out of the filing of a prior foreign application, under R. S. 4887.

Under R. S. 4886, two years prior public use of an invention in this country is an absolute bar to the validity of a patent for the invention issued upon an application filed thereafter, irrespective of when or where the inventive act occurred. The statute applies to foreign and domestic inventors without distinction.

It says:

*"Any person who has invented . . . any new and useful . . . machine . . . not in public use . . . in this country for more than two years prior to his application, may . . . obtain a patent therefor."*

By the express finding of the court below, concurred in by this court, the invention of '020 was in public use in this country in defendant's Hardinge mill "which embodied the plaintiff's principles" not later than *June, 1921*.

But, the application for '020 was not filed until *April 27, 1926*.

This fact, it is believed, escaped the attention of this court.

## IV.

**IN AFFIRMING THE HOLDING OF THE COURT BELOW THAT PLAINTIFF'S '149 PATENT IS VALID AND INFRINGED, THIS HONORABLE COURT INADVERTENTLY OVERLOOKED THE FACT THAT JAPANESE PATENT 41,728 IS SUBSTANTIALLY IDENTICAL WITH CLAIM 1 OF '149 AND THAT JAPANESE PATENT 42,563 IS SUBSTANTIALLY IDENTICAL WITH CLAIM 2 OF '149 AND THAT THOSE PATENTS, HAVING BEEN APPLIED FOR IN JAPAN MORE THAN TWELVE MONTHS PRIOR TO THE FILING OF APPLICATION FOR '149, NULLIFY '149 UNDER THE EXPRESS TERMS OF R. S. 4887.**

Claim 1 of '149 is:

“(1) A method of forming a finely divided chemically reactive lead powder of such fineness and activity as to be readily changed chemically on contact with air, which comprises introducing relatively large masses of lead into a rotatable vessel, rotating said vessel at a relatively low speed and forming said lead powder by attrition of said lead masses resulting from the rubbing of said masses against each other.”

Claim 1 of Japanese Patent '728 is:

“(1) In order to achieve the purpose recorded above; a method of manufacturing chemically reactive lead powder is claimed, a special feature of which is throwing lumps of lead into a rotating vessel and by rotation of the vessel grinding the lumps of lead to small pieces.”

Claim 2 of '149 is:

“2. A method of forming a finely divided chemically reactive lead powder of such fineness and activity as to be readily changed chemically on exposure to air, which comprises introducing relatively large masses of lead into a rotatable



vessel, rotating said vessel at a relatively low speed, *introducing a current of air into said vessel*, forming said lead powder by attrition of said lead masses resulting from the rubbing of said lead masses against each other, and removing the said powder from said vessel by means of said current of air."

Claim 1 of Japanese Patent '563 is:

"1. In order to achieve the object recorded earlier in this record, a method of manufacturing chemically reactive lead powder is claimed, a special feature of which is throwing lumps of lead into a rotating vessel, and *blowing currents of air or other inactive gasses into the vessel* during rotation to force the small particles produced by rubbing out of the vessel."

Moreover, claim 2 of Japanese patent '563 refers merely to "currents of inblowing air," and claim 3 thereof speaks only of the "force of the wind."

Substantial identity of claims only is required to make applicable the twelve months limitation of R. S. 4887. *United Shoe Machinery Co. v. Duplessis Shoe Machinery Co.*, 148 Fed. 31, affirmed (C. C. A. 1) 155 Fed. 842. The foregoing respective claims are virtually identical in form as well as in substance.

Moreover, it is not necessary that every element and feature of the patent shall be clearly shown by a single foreign patent, but several such references may be combined to negative patentability of the claims. *In re Mulligan*, 83 Fed. (2d) 917.

Japanese Patent '728 was applied for November 21, 1920 (DX 111).

Japanese Patent '563 was applied for November 27, 1920 (DX 112).

Application for '149 was filed January 30, 1922 (PX 2). '149 is, therefore, invalidated by Japanese

Patents '728 and '563 under the express terms of R. S. 4887.

The court below did not discuss Japanese Patent '563 in relation to '149. It made no mention whatever in its opinion of Japanese Patent '728.

These facts, it is believed, were overlooked by this court.

## V.

**IN ITS AGREEMENT WITH THE CONCLUSION OF THE COURT BELOW THAT DEFENDANT'S TUDOR MILL OPERATION, THOUGH NOT AN ABANDONED EXPERIMENT, "CAN NOT BE CONSIDERED AS A PRIOR PUBLIC USE AGAINST THE PATENTS IN SUIT" BECAUSE "THERE WAS ABSOLUTELY NO SUGGESTION OR THOUGHT OF BLOWING OR FORCING THE AIR INTO THE DRUM" AND BECAUSE "THE DEFENDANT NEVER HAD THE SLIGHTEST CONCEPTION OF THE EFFECT WHICH EVEN THIS GENTLE CIRCULATION OF AIR HAD UPON THE LEAD SURFACE TO BE ABRADED," THIS HONORABLE COURT INADVERTENTLY OVERLOOKED THE POSITIVE DOCUMENTARY EVIDENCE WHICH CLEARLY ESTABLISHES THE CONTRARY.**

With respect to defendant's Tudor mill operation, the court below found:

"Finally, in July, 1915, the defendant bought a Tudor mill duplicating those seen by their engineer in Germany and set it up in its plant, putting it into operation *about the middle of 1916*. . . . Various runs were made for the purpose of obtaining a product and in 1917 and 1918 batteries constructed from the powder were sold to New York Railways Company. The first order was for 70 sets of bat-

teries at a price of \$65,000 comprising some 16,000 plates. A second order was for about a fifth of that amount." (R. II, 1173.)

" . . . I cannot agree with the plaintiff that the whole incident must be dismissed as an abandoned experiment. . . . There is nothing to indicate that the product was not satisfactory, but the mill never produced powder in sufficient quantity to justify its *continuation in commercial use*. Nevertheless, I think it might stand as a prior public use against the plaintiff's patents, provided it really anticipated the plaintiff's invention . . . (R. II, 1174).

The court below thus found and held that the Tudor mill was in *commercial use* in defendant's Philadelphia plant in 1917 and 1918; that it was not an abandoned experiment; and that it might stand as a prior public use against plaintiff's patents, if it anticipated plaintiff's invention. Upon the latter question the court below said:

" . . . I am of the opinion that it cannot be considered as a prior public use against the patents in suit, because its entire operation failed even to approximate the essential idea of the plaintiff's process patent. . . . if the method of operation be carefully considered it will be seen how far away from the spirit it is." (R. II, 1175.)

This conclusion the court below predicated solely upon the finding that:

"*There was absolutely no suggestion or thought of blowing or forcing the air into the drum.*" (R. II, 1176.)

And,

"The defendant never had the slightest conception of the effect which even this gentle circulation of air had upon the lead surfaces to be abraded. The correlation between oxidation in the drum and increased yield was not perceived." (R. II, 1176.)

But in so finding and holding, the court below apparently disregarded the unquestioned documentary evidence which conclusively establishes the contrary.

DX 78 is dated July 24, 1917. It represents a report made to defendant on that date by Mr. Kershaw, the engineer in immediate charge of the operation of the Tudor mill. It is set out verbatim on pages 19 to 22 of defendant's main brief. It records the results of experiments made with the Tudor mill. It conclusively shows that defendant fully appreciated the oxidizing effect of the circulation of air upon the lead surfaces to be abraded, and correlation between oxidation in the drum and increased yield.

Thus, DX 78 states:

*"... the greater the internal ventilation through the machine the greater the speed at which it can be operated without exceeding its temperature limit, thus increasing the ease of control and the output."*

Again, under the heading "GENERAL OPERATIONS," DX 78 states:

*"Control the character of the product as far as possible by the external and internal ventilation systems, installing fans if necessary."*

DX78, moreover, establishes the identity between defendant's Tudor mill and the process of plaintiff's '150 patent.

Thus it shows an operating load of 1800 to 2400 pounds at a speed of 12.5 to 15 revolutions per minute, and at a temperature ranging from 165 to 185° F. (73.9-85° C.) and the production under those conditions of 40 to 60 pounds of lead dust per hour having a lead oxide content of 60 to 80%.

Furthermore, the evidence shows that the construction of the mill was the precise construction of the mill described in '150, being a rotatable cylinder having its walls pierced all over with one-eighth inch holes (R. I. 444, 445). The Tudor mill had, however, a length of  $36\frac{3}{4}$ " instead of 60" (R. I. 444).

Defendant's Tudor mill was in *commercial use* in this country in 1917 and 1918. The process thereof was therefore known and used in this country before the earliest date found for plaintiff's invention of the process of '150, which the court below fixed as August, 1919. Likewise, defendant's Tudor mill was in public use in this country for more than two years before the filing of application for any of the patents in suit, the earliest of which was filed January 30, 1922. Upon both grounds the Tudor mill invalidates plaintiff's '149, '150 and '020 patents under the express terms of R. S. 4886.

These facts, established by incontrovertible documentary evidence, were, it is believed, inadvertently overlooked by this court.

## VI.

**THIS HONORABLE COURT APPARENTLY OVERLOOKED THE FACT THAT THE FINDING BY THE COURT BELOW OF INFRINGEMENT OF PLAINTIFF'S '149 PATENT BY DEFENDANT'S HARDINGE MILL PROCESS IS CONCLUSIVELY REFUTED BY THE CLEAR PREPONDERANCE OF EVIDENCE.**

The court below held defendant's Hardinge mill process to be an infringement of the process claims of '150, which call for:

- "1. Impinging a current of air on lead masses in a dry state;
2. Abrading the lead masses;

3. Controlling the temperature to obtain a finely divided powder containing a large proportion of *oxidized lead*." (R. II, 1167.)

Yet the court below likewise found defendant's Hardinge mill process to be also an infringement of plaintiff's '149 patent, although it expressly recognized that "'149 does not disclose the oxidizing function of the air or refer to the highly important element of the process having to do with the temperature control necessary to its successful operation." (R. II, 1188.)

In so holding, the court below not only failed to give effect to the foregoing distinction between the process of '149 and that of '150, expressly recognized in its opinion, but also failed to give effect to the other evidence which conclusively establishes non-infringement of '149 by defendant's Hardinge mill process.

Thus, the evidence clearly shows that the product of '149 is a *metal* powder, not a powder of lead oxide intermingled with powder of metallic lead.

Again, patent '149 discloses that the heat generated by friction is to be radiated and that the powder is to be removed from the mill as soon as it is formed; whereas, defendant does not operate at room temperature, but at temperatures above 60° C.

Defendant, moreover, does not blow its powder out of the mill as soon as it is formed. It permits the powder to remain in the mill for a long period of time and until it is discharged by the classifying action of the mill. The function of the air used by defendant is not to blow the product out of the mill at any time. On the contrary, the sole purpose of air introduced into defendant's mill is oxidation (R. I, 482).

These facts, it is believed, escaped the attention of this Honorable Court.

**CONCLUSION.**

Defendant's plant is old. It has been operating in the same manner that it is now operating since at least as early as June, 1921.

For the reasons hereinbefore set forth it appears that this Honorable Court inadvertently overlooked and failed to give effect to the clear, mandatory principles of law applicable to the express findings by the court below, in which this court concurred, under the express terms of R. S. 4886 and R. S. 4887.

For this court to permit defendant's plant to be closed by injunction, in the light of the foregoing considerations and until those matters have been given full and mature consideration by this court upon rehearing, would, it is submitted, result in grave injustice.

Defendant therefore prays that it be granted a rehearing as to each of the matters above specified.

All of which is

Respectfully submitted,

AUGUSTUS B. STOUGHTON,

HUGH M. MORRIS,

A. F. KWIS,

E. S. W. FARNUM, JR.,

*Counsel for Defendant.*



**ORDER DENYING PETITION FOR REHEARING.**

(Filed September 14, 1938.)

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IN THE UNITED STATES CIRCUIT COURT OF APPEALS,  
FOR THE THIRD CIRCUIT.

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No. 6309. March Term, 1938.

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*The Electric Storage Battery Co.,*  
Defendant-Appellant,

v.

*Genzo Shimadzu and Northeastern Engineering Corp.,*  
Plaintiffs-Appellees.

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**SUR PETITION FOR REHEARING.**

AND NOW, to wit, September 14, 1938, after due consideration, the petition for rehearing in the above-entitled case is hereby denied.

Philadelphia,

J. WARREN DAVIS,  
*Circuit Judge.*

(Endorsements.)—Order Denying Petition for Rehearing Received and Filed September 14, 1938. Wm. P. Rowland, Clerk.

**CLERK'S CERTIFICATE.**

UNITED STATES OF AMERICA,  
 EASTERN DISTRICT OF PENNSYLVANIA, } *Sct.*  
 THIRD JUDICIAL CIRCUIT,

I, Wm. P. ROWLAND, Clerk of the United States Circuit Court of Appeals for the Third Circuit, DO HEREBY CERTIFY the foregoing to be a true and faithful copy of the original Transcript of Record (in two volumes) and proceedings in this Court in the case of Electric Storage Battery Co., Defendant-Appellant, v. Genzo Shimadzu and Northeastern Engineering Corp., Plaintiffs-Appellees, No. 6309, on file, and now remaining among the records of the said Court, in my office.

~~IN~~ TESTIMONY WHEREOF, I have hereunto subscribed by name and affixed the seal of the said Court, at Philadelphia, this twenty-first day of September, in the year of our Lord one thousand nine hundred and thirty-eight and of the Independence of the United States the one hundred and sixty-third.

(Seal)

WM. P. ROWLAND,  
 Clerk of the U. S. Circuit Court of Appeals. Third Circuit.

**SUPREME COURT OF THE UNITED STATES**

**ORDER ALLOWING CERTIORARI—Filed December 5, 1938**

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Third Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.

